This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

9015 00002983 8b

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

J. E. CARNE, F.G.S., Government Geologist.

MINERAL RESOURCES.

No. 26.

FELSPAR IN NEW SOUTH WALES.

BY

L. F. HARPER, F.G.S.,

Geological Surveyor.

Issued by direction of the Honorable J. C. L. Fitzpatrick, M.L.A., Minister for Mines.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1917.

136—A

Digitized by Google

Science Library
TN
122
.N421
A3
no. 26

Digitized by Google

Transf. to Sci. Lib. 7-8-54
New So. Wales Geol. Surv.
4.
12-10-1923

LETTER OF TRANSMITTAL.

Geological Survey Branch,
Department of Mines,
Sydney, 25th July, 1917.

Sir,

I have the honor to submit for publication No. 26 of the Mineral Resources Series dealing with the occurrence of Felspar in New South Wales. This note has been prepared by Mr. L. F. Harper, F.G.S., Geological Surveyor.

Felspar is used principally in various branches of the pottery and ceramic industries, and has hitherto been to a great extent imported.

It is possible that owing to the practical impossibility of obtaining foreign supplies, the opportunity may arise of developing local deposits, and the object of Mr. Harper's report is to direct attention to deposits in the State which have up to the present been examined.

I have the honor to be,
Sir,
Your obedient Servant,
JOSEPH E. CARNE,
Government Geologist.

The Under Secretary for Mines.

Digitized by Google

Digitized by Google

1065
8896
4v
New

Felspar in New South Wales.

INTRODUCTION.

HITHERTO practically all the felspar used in New South Wales has been imported; but owing to existing conditions as regards oversea freightage, its importation has become practically prohibitive, and consumers are now forced to look round for a local supply.

Certainly the present demand probably does not exceed 100 tons per annum, but there are many imported articles for the manufacture of which felspar is necessary, and there appears no reason why local industries should not be established for their manufacture.

Felspar mining, treatment, and uses are very little understood in New South Wales, and the object of this report is to review the whole question, and bring the mineral under the notice of the prospector with a view to the location of payable deposits. It is also desired to supply the commercial world with such particulars as may assist in establishing both a supply and a demand, in order that New South Wales may be independent of imported ground felspar and many of the finished articles for which its use is essential.

Up to the time of writing this report, only five deposits* have come under the writer's notice, but this may be due to the fact that hitherto there has been no demand for local felspar, and the prospector has not paid any attention to its occurrence.

There appears no reason why extensive deposits of felspar should not be found in New South Wales, for geological conditions are favourable over many areas of granite country within the State.

The time is undoubtedly opportune for the development of the industry, for it is likely to be protected to the extent of prohibitive importation freights for some time to come, thus enabling initial costs to be met and other preliminary difficulties to be overcome before competition from outside sources has to be faced.

A word of advice may be tendered to prospectors as to the value of this material, in order that an exaggerated idea be not entertained as to its value. Felspar is used in the ceramic arts, particularly for porcelainising, and before the finished article is placed on the market the raw material has to pass through numerous processes, so that it will not carry a great initial cost.

The advantages of a good deposit of felspar, convenient to market, are the low mining costs and the tonnage likely to be disposed of annually if the price is reasonable. As an example, it may be pointed out that in 1915,

* See page 9

Digitized by Google

the United States of America produced 113,769 short tons of felspar, valued at about 22s. per ton, and whilst nothing like that tonnage would be utilised in New South Wales, still the price paid would be higher, if only to the extent of freight costs.

A table of the world's production of felspar recently published* is as follows :—

FELSPAR sold in principal producing countries, 1911–1915.

	1911.		1912.		1913.		1914.		1915.	
	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).
United States	92,700	579,008	86,572	520,562	120,955	776,561	125,419	629,873	113,769	629,356
Belgium (a)	....	1,655	....	660	(b)	(b)	(b)	(b)	(b)	(b)
Canada (c).....	17,723	51,989	13,733	80,916	15,935	56,841	18,060	70,824	15,455	59,124
Germany (a)..... (Bavaria)	3,499	13,689	7,348	49,581	(b)	(b)	(b)	(b)	(b)	(b)
Italy (d).....	39,417	44,585	37,416	44,079	35,569	39,172	35,963	43,305	(b)	(b)
Madagascar (a) ..	....	....	451	....	(b)	(b)	(b)	(b)	(b)	(b)
Norway (c) (a)....	33,429	124,096	43,919	146,325	(b)	(b)	(b)	(b)	(b)	(b)
Sweden (a)	29,942	39,743	37,814	38,682	(b)	(b)	(b)	(b)	(b)	(b)

(a) Statistics taken from Mines and Quarries, Gen. Report and Statistics. Pt. 4, London.

(b) Statistics not available.

(c) Reports on Mineral Production of Canada : Canada Dept. of Mines.

(d) Includes quartz; statistics taken from Rivista del Servizio Minerario, Rome.

(e) Export figures.

*"Felspar in 1915." By Frank J. Katz, Dept. of Interior, U.S. Geol. Survey, Min. Resources, U.S.A., 1915. II. (7.), Washington, 1916, page 53.

Digitized by Google

ACKNOWLEDGMENTS.

The writer is greatly indebted to the works of Frank J. Katz*, A. S. Watts,† and Hugh S. de Schmid, M.E.,‡ for much of the information contained in this pamphlet, and these authors have been quoted from freely.

Mr. A. P. J. McGauran, Sydney Agent for the Nambucca felspar deposit, has been of great assistance with regard to local information concerning the occurrence of felspar in New South Wales, and the market possibilities.

VARIETIES OF FELSPAR.

According to Mr. Katz, "Common felspars are crystalline compounds of silica, alumina, and one or more of the bases, potash, soda, and lime. There are two principal classes of felspar—the one including the potash and potash-soda varieties, the other including the soda, soda-lime, and lime varieties." The mineralogical names of the pure potash felspars are Orthoclase and Microcline, and both are alike in their chemical composition and physical properties, so that commercially they may be considered identical. The theoretical composition of both is silica 64·7 per cent., alumina 18·4 per cent., potash 16·9 per cent.

Albite is the pure soda variety, with the following composition :—Silica, 68·7 per cent.; alumina, 19·5 per cent; soda, 11·8 per cent. It is rare, however, that the theoretical standard is maintained, and the alkalies occur in varying proportions. One essential from a commercial point of view is the total proportion of lime admissible.

Felspars are among the most widely distributed minerals, and occur in nearly all igneous rocks. As a rule, however, the grain is small, and they are so closely associated with other minerals as to be of no commercial importance.

Coarse-grained granites, known as pegmatites, are practically the sole source of the world's felspar supplies, and these generally occur as dykes or irregular-shaped masses, from which the coarse crystalline and comparatively pure felspar may be won by hand-picking. The mode of occurrence renders it difficult to predict the extent of any given deposit, as they are most frequently lens-shaped, and the proportion of felspar present must of necessity be an unknown quantity prior to working. It is common for the lenses when occurring in granite or other massive rock to follow more or less parallel fractures, so that prospecting should be carried out with this in view.

The following minerals are most commonly associated with the felspar in pegmatite :—Quartz, muscovite or white mica, and biotite or black mica, with lesser quantities of tourmaline, garnet, magnetite, and iron pyrites, the latter occurring as small scattered crystals or miniature bunches of crystals.

---

* "Felspar in 1915." By Frank J. Katz. Dept. of Interior, U.S. Geol. Survey, Min. Resources, U.S.A., 1915, II. (7) : Washington, 1916.

† "Mining and Treatment of Felspar and Kaolin in the S. Appalachian Region." Dept. of Interior U.S. Geol. Survey, Bulletin 58, Min. Tech. I. : Washington, 1914.

‡ "Felspar in Canada." Canada, Department of Mines : Ottawa, 1916.

Digitized by Google

Mining and Milling.

The methods adopted in mining a felspar deposit are very simple, and consist of an open cut, by which means costs are reduced to a minimum, for it is possible to avoid mining valueless portions of the deposit. If the occurrence is on a hillside, a graded track should be cut into the floor of the quarry, and, if the output justifies it, two light lines of rails laid, one for trucking out the hand-picked felspar and the other for removing quarry refuse.

After the material has been hand-cobbed and picked, the method of grinding felspar in America, according to Mr. F. J. Katz*, is as follows :—"The methods used for grinding felspar for pottery and enamel ware are similar in a general way in all the Eastern States. Some spar is first burned in kilns, which serves to fracture it and thus facilitate grinding. Most felspar, however, is fed, just as it comes from the quarry, into chaser mills. The material from the chasers is screened, the tailings being returned for recrushing, and the fines going to the tube mills for fine grinding.

" For use in pottery it is so ground, as screen tests on commercial pottery spar have shown that 99·3 to 99·8 per cent. passes through a 100-mesh screen, and 96·7 to 98·2 per cent. through a 200-mesh screen. Some felspar prepared for use in abrasive soaps is even more thoroughly ground to reduce it to extreme and uniform fineness."

Only a very small quantity of felspar has hitherto been prepared in New South Wales, and considerable difficulty appears to have been experienced in turning out a satisfactory article. One method of treatment adopted here was to pass the crude material through a rock-breaker, and feed to a Krupp ball mill. Very fine pulverisation is thus secured, but the product is found to contain quite an appreciable quantity of metallic iron. This is a most objectionable feature when the felspar is used for ceramic purposes, and a pure white glaze is essential. Experiments are now being conducted with a view to extracting the iron by means of an electro-magnet, and although it adds to costs, the results appear to be very satisfactory. On the other hand, the grinder raises objections to treating the material owing to the wear and tear on his plant, and naturally his charges are proportionately high.

Another method of treatment adopted has been to have the felspar ground in a buhrstone mill. This appears to have been far from satisfactory from all points of view, for not only was the finished product of a decided cream colour owing to the addition of a large proportion of pulverised buhrstone, but the wear and tear on the latter was disastrous. Certainly the trouble may be largely due to inferior buhrstones, which by wearing away would both adulterate and discolour the ground felspar.

As far as can be ascertained this method of treatment is generally adopted in America with satisfactory results, and the fine material is fed to ball mills. These, according to Mr. A. S. Watts,† " are steel-barrel tumbler mills 6 to 7 feet long, and of about the same diameter. They are lined with hard wood or silica blocks and are charged with French flint pebbles 2 to 3 inches in diameter. The revolving of the mill causes the pebbles to roll or slide, thus pulverising the felspar."

---

* " Felspar in 1915." By Frank J. Katz. Min. Resources of the United States, 1915. Part II, p. 47.

† " Mining and Treatment of Felspar and Kaolin," p. 65, Bulletin 53, Mineral Technology I. Dept. of the Interior, Bureau of Mines, Washington.

Digitized by Google

In view of the troubles experienced by local grinders of felspar, the suggestion is made that before grinding, heating and quenching be tried, particularly when a hard variety has to be dealt with. This should reduce the wear and tear on the plant, but it must be borne in mind that potash felspars begin to soften at 1150° C., so that excessive temperatures must be avoided.

Quality.

The quality of felspar from a ceramic point of view is dependent to a very great extent upon colour. According to A. S. Watts,* a high grade felspar is obtained from Maine, U.S.A., the colour of which has been accepted as a standard. The analysis of this felspar is as follows :—

Chemical Analysis of standard Maine Felspar.

(Analysis by Ohio Geological Survey.)

Silica (SiO_2)	71·75
Alumina (Al_2O_3)	16·70
Ferric oxide (Fe_2O_3)	·14
Titanium dioxide (TiO_2)	·03
Lime (CaO)	·25
Magnesia (MgO)	.....
Loss on ignition	·35
Potash (K_2O)	8·59
Soda (Na_2O)	2·99
	100·80

It will be seen that the iron contents in the above "standard colour" felspar is ·14, and on comparing analysis of the Nambucca River and Hartley deposits, we find even a lower iron percentage. (*See* pp. 9-13.)

When it is recognised that discoloration in ceramic glazes or enamels is due almost entirely to iron contents in the mixture used, it is self-apparent that the deposits mentioned should provide a material giving high grade results.

The felspar deposits which have come under the notice of the writer all contain a very small percentage of iron pyrites, but there is every reason to believe that by careful hand-picking, a large proportion of the pyrites could be eliminated.

Other iron-bearing minerals such as biotite (black mica), garnet, or tourmaline, if present in sufficient quantity, have a deleterious effect upon the colour of the ground felspar, and care should be taken to reject as much as possible of the material containing these minerals.

Other Impurities.

An excessive percentage of quartz (less than 20 per cent. is desirable in the ground product) is a drawback to felspar for use in the ceramic arts, as it affects the fusibility; but in cases where there is an intimate intergrowth of quartz and felspar incapable of economic hand-picking, the difficulty may be overcome if a sufficient quantity of pure felspar is added.

* *Ibid.*, p. 25.

Digitized by Google

Mr. F. J. Katz* points out that "The requirements of the potter's trade demand that in general the percentage of free quartz associated with the felspar used for this purpose shall not exceed 20 per cent. in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent. of free quartz. In order to be profitably worked, in most felspar mines between one-fourth and one-half of the total material that must be excavated should contain less than 20 per cent. of free quartz."

According to the same authority, "The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial felspar, and chemically this mineral is not injurious. It is, however, exceedingly difficult to pulverise the thin, flexible mica plates to a fineness equal to that required in the felspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

Uses.

Felspar is used principally in the manufacture of pottery, enamelware, porcelain, chinaware, for enamel bricks and tiles, and in the various grades of ceramic products.

A limited amount is utilised in abrasive soaps, particularly those used for window cleaning, and also for bonding purposes in the manufacture of emery and carborundum wheels.

A comparatively few tons of selected high grade potash felspar are used in the manufacture of artificial teeth.

According to Mr. de Schmid†, the question of extracting potash from felspar has received considerable attention within the past few years, but he states that "there is no evidence to show that any of the suggested processes can be considered commercially practicable, the cost of extraction being prohibitive." The same writer refers to recent attempts to place on the market finely-ground potash spar as a fertiliser, but here, again, the results do not appear to support the claims made for it.

When close to a market and easily won, low-grade felspar may be employed as poultry grit with advantage, coarse grinding being the only necessary preparation.

* *Ibid.*, pp. 45, 46. † "Felspar in Canada." Dept. Mines, Canada: Ottawa, 1916, p. 97.

Digitized by Google

NEW SOUTH WALES' DEPOSITS.

Up to the present the known deposits of felspar of any extent in New South Wales which have come under the notice of the writer are as follows, but it may be that others will be located now that the attention of the prospector and manufacturer has been directed to its uses and commercial possibilities.

The following deposits of felspar are described in detail:—

1. Within portion 16, parish of Valley Valley, county Raleigh, about 8½ miles by road north-west of Nambucca Harbour.
2. Near portion 282, parish of Lett, county of Cook, 2 miles north-east from the village of Hartley, and 5 miles from Lithgow railway station.
3. In the parish of Bodangora, county Lincoln, between the 16 and 17-mile posts (from Wellington), on the Wellington-Mudgee road.
4. Barrier Ranges, between Purnamoota and Waukeroo, and in the neighbourhood of Euriowie, 40 miles north of Broken Hill.
5. In the parish of Moonbi, county of Inglis, 3½ miles west of Kootingal Railway Station, 295 miles north of Sydney.

Detailed Descriptions.

No. 1.—Near Nambucca.

The syndicate holding this deposit is devoting considerable energy to establishing a market for their product, and there appears no reason why their enterprise should not eventually meet with success.

Mr. W. J. Hammond, of Bellingen, one of the principals, may be credited with being the pioneer of the felspar industry in New South Wales, and it was through him that felspar was proclaimed a mineral under the Mining Act.

Mr. A. P. J. McGauran, of 33 Rowe-street, Sydney, is the representative of the syndicate, and is doing much by his energy and enthusiasm to create a market for locally-produced felspar.

The deposit is situated on private land, about 2½ miles west of the main road from Nambucca to Bellingen, and is 8½ miles from the former, to which the felspar is carted and shipped to Sydney.

The geological formations in this neighbourhood consist of slates of Silurian age, which have been intruded by a mass of granite containing pipes of pegmatite. Several pipes were examined, in some of which felspar predominates, and in others quartz, and as these occur near the top of a range of steep hills, quarrying facilities are good.

Up to the present, only one pipe has been opened up, the apparent surface dimensions of which are 60 feet long by 30 feet wide. The quarry is about 12 feet in diameter, and has a maximum depth of 4 feet, running out to nothing on the down-hill side.

Digitized by Google

The felspar occurs in masses, is crystalline, milky-white in colour, a comparatively undecomposed, even at the grass roots. Occasional sm blebs of quartz occur in the spar, also localised specks of iron pyrites a muscovite (white mica), whilst joint faces are slightly stained with ir oxide. Blocks of practically pure felspar up to 3 feet in diameter are bei shot out, which, on breaking to a size suitable for bagging, require very lit hand-cobbing to eliminate impurities.

Pockets of pure quartz occur interspersed with the felspar masses, a irregular-shaped patches of aplitic granite, and at times considerable har picking is necessary to ensure only a first-grade product being bagg Judging by the work done, not less than 50 per cent. of the deposit consi of high-grade felspar, and an estimate of the quantity available has be based upon this assumption, although it is admittedly conservative unc existing appearances. In other pipes and lenses of pegmatite in t neighbourhood examined by the writer, quartz or aplitic granite predominat over the pure felspar, but it may be that, if sunk on, payable deposits of pu felspar would be disclosed. Similar conditions may pertain throughout the pipes, at different levels, and possibly at no great depth beneath t surface the main characteristics of each pipe will vary, so that prospecti should not be confined to any one outcrop.

With regard to the impurities in this felspar, it appears probable that reasonable care be exercised in mining and bagging, no great amount hand-picking or cobbing will be necessary to insure a first-grade marketa product. Care should be exercised to eliminate the pieces containing undue proportion of quartz, excessively iron-stained fragments, or pie with "nests" of iron pyrites.

As an illustration of the quality of the first-grade article from this depo the following analysis, made in the laboratory of the Department of Min may be quoted :—

2639–16.

Silica (SiO_2)	64·40
Alumina (Al_2O_3)	19·98
Ferrous and Ferric oxide $\left\{\begin{matrix}Fe_2O_3\\FeO\end{matrix}\right\}$	0·05
Magnesia (MgO)	absent
Lime (CaO)	0·26
Soda (Na_2O)	2·85
Potash (K_2O)	11·99
Total moisture (H_2O)	0·48
Titanium dioxide (TiO_2)	absent
Manganous oxide (MnO)	*trace
Barium oxide (BaO)	*trace
Lithium oxide (Li_2O)	nil
	100·01

Comparing the above with an analysis of "a high-grade felspar," giv on page 7, it will be seen that the Nambucca felspar can, on chemi analysis, claim to be of a high-grade quality.

* Less than 0·01 per cent.

Digitized by Google

Associated with the felspar and quartz in the pipes is a milky-white granite (aplite) composed mainly of medium-grained crystalline quartz and felspar, with occasional small nests of iron pyrites. An analysis of this rock indicates the following general composition :—

ANALYSIS of "country rock," Nambucca felspar deposit.

Silica (SiO_2)	76·50
*Alumina (Al_2O_3)	12·24
Ferric oxide (Fe_2O_3)	0·50
Ferrous oxide (FeO)	0·56
Soda (Na_2O)	3·43
Potash (K_2O)	3·94

This composition approaches that of Cornish stone, largely used in the manufacture of whiteware, but its hardness may be against its economic use. Until practical tests have been made, however, it is not possible to express an opinion as to its utility in the ceramic industry.

As this material has to be hand-picked from the felspar, it would be greatly in favour of economic working if a market could be found for it.

An attempt to estimate the quantity of commercial felspar in this neighbourhood is somewhat premature owing to the very limited amount of prospecting work carried out up to the present. Quantities will depend almost entirely upon two factors, namely, the vertical dimensions of the pipes, and the predominating mineral therein. As pointed out, some of the outcrops show an excessive amount of quartz, whilst in the deposit being worked felspar predominates.

It is more than probable, however, that the relative proportions of these minerals will vary at different depths in the individual pipes, and one which is not workable at the outcrop may greatly improve if sunk on for a few feet, or *vice versa*.

Assuming that about 50 per cent. of the deposit being worked will be marketable, and allowing a depth of 50 feet, it is reasonable to assume that not less than 3,000 or 4,000 tons of felspar will be available.

DEPOSIT NO. 2.—NEAR HARTLEY.

This deposit is about half a mile off the main road from Mount Victoria to Lithgow, and less than 5 miles from the railway at the latter town.

The deposit is on Crown land, and Messrs. Basser and Morris have an application pending for a mineral lease to cover the deposit.

The geological formations to the north and east of the deposit consist of sandstones and conglomerates of Upper Marine age. These beds rest on an extensive mass of granite, which crops out to the west of the Lithgow road, and contains the felspar deposit.

An open cut some 60 feet long by 20 feet wide has been sunk to a depth of about 6 feet, exposing a more or less lens-shaped mass of quartz and felspar. The deposit does not appear to be confined between strict walls, for in places large bunches of felspar and quartz extend beyond the apparent walls, whilst in others there is a well defined line of demarcation. The strike of the deposit is approximately S. 10° E., and it appears to gradually pinch out at either extremity, until normal granite only is visible.

* Contains traces of phosphoric anhydride and titanium dioxide.

Digitized by Google

The felspar is crystalline, and occurs in bunches up to 4 feet in diameter which blebs of quartz of various sizes are noticeable, with occasional quar crystals up to 2 inches in diameter. Large masses of amorphous silica occ also patches of coarse grained granite in which felspar predominates.

Only one deposit was seen by the writer, but further prospecting shou reveal others, and quartz exposures are likely to pass downwards in workable deposits of felspar.

Nature of the Felspar.

The felspar is very slightly kaolinised, and contains occasional small ble of quartz, but no mica or other mineral was observed. On some of the fac slight iron-staining occurs, but the greater portion of the material is of pure milky-white colour.

The following analysis, made in the laboratory of the Department Mines, indicates the quality of the hand-picked spar :—

ANALYSIS of Felspar from near Hartley.

Silica (SiO_2)	65·52
Alumina (Al_2O_3)	20·14
Iron oxide	0·10
Magnesia (MgO)	.....
Lime (CaO)	.....
Soda (Na_2O)	3·49
Potash (K_2O)	9·88
Moisture	.....
Titanium dioxide (TiO_2)	nil
Phosphoric anhydride (P_2O_5)	trace

As the foregoing analysis indicates, this felspar is comparatively free fro impurities, and by discriminate hand-picking it should be possible to procu a high-grade product.

The associated granite may have some value as Cornish stone, and th prospectors are advised to submit samples to firms interested in the ceram industry.

The evidence available, and known modes of occurrence of such deposit render it difficult to form an estimate of the quantity available. Probabl not more than 30 per cent. of the material showing in the present quar would pay to bag, and if the deposit extends to a depth of only 40 fee which may or may not prove conservative, it is estimated that from 7 to 1,000 tons of felspar could be obtained from the deposit under review.

Further prospecting in the neighbourhood is advocated, however, in th hopes of augmenting the supply, for its proximity to a market is a favourab factor in economic working.

DEPOSIT NO. 3.—ON THE WELLINGTON-MUDGEE ROAD.

This occurrence is well seen on the main road from Wellington to Mudge the best exposures being in the road cutting between the 16 and 17 mil posts.

The felspars occur as porphyritic crystals up to 2 inches in length, an so thick are they in this particular spot that hundreds of tons could b collected without hand-picking.

The granite mass in which they occur occupies an area of over 50 squar miles, but as far as the writer is aware, the coarsely porphyritic type is ver localised.

Digitized by Google

The accompanying analysis has been made in the departmental laboratory —

Silica (SiO_2)	65·10
Alumina (Al_2O_3)	18·69
Ferric oxide (Fe_2O_3)	0·60
Ferrous oxide (FeO)	0·18
Magnesia (MgO)	0·08
Lime (CaO)	0·44
Soda (Na_2O)	2·79
Potash (K_2O)	10·61
Combined moisture (H_2O+)	0·58
Included moisture (H_2O-)	0·12
Titanium dioxide (TiO_2)	0·25
Zirconium dioxide (ZrO_2)	nil
Phosphoric anhydride (P_2O_5)	trace *
Vanadic oxide (V_2O_5)	nil
Sulphur trioxide (SO_3)	0·02
Chlorine (Cl)	nil
Manganese oxide (MnO)	0·04
Barium oxide (BaO)	0·78
	100·28

The crystals vary in colour on the surface from a dirty brown to a pale red, and on breaking are found to have a decided yellowish tint. This is due to the percentage of iron present, which is higher than in the felspar from Deposits 1 and 2.

The distance of this deposit from rail and a market would be a big drawback to economic handling, even if the quality were really high grade; moreover, the mode of occurrence is unfavourable to cheap winning once the surface accumulations have been removed.

The occurrence is interesting from a scientific point of view, but there appears little prospect of it becoming of economic importance.

No. 4.—The Barrier Range Deposits.

This group of deposits is situated from 30 to 40 miles north of Broken Hill, and has not been visited by the writer, but the following information is extracted from a work by Mr. J. B. Jaquet, A.R.S.M., F.G.S.,† Chief Inspector of Mines :—

"Between Purnamoota and Waukeroo you have granite hills occupying a belt of country 9 miles long by 3 miles broad. The constituent minerals are quartz, which may be massive or in the form of grains; felspar, consisting of orthoclase and plagioclase; and light mica. In the neighbourhood of Waukeroo and Euriowie, in addition to the primary minerals, tourmaline, cassiterite, and fluorspar occur. The crystals of orthoclase frequently have assumed enormous dimensions; and such crystals are occasionally associated with plates of mica, which may be of value in commerce.

"In every case the granite is very coarsely crystalline. If the outcrop of a dyke be followed along it will be found to consist in one place solely of felspar . . . . . "

* Less than 0·01 per cent.

† "Geology of the Broken Hill Lode and Barrier Ranges." Geology No. 5. Memoirs Geol. Survey, N.S.W.: Sydney, 1894, pp. 60, 61.

Digitized by Google

From the above it is apparent that there are extensive deposits of felspar in this region. Much of the material is pure white in colour with no impurities, and its general chemical composition is indicated by the following analysis published in 1893* :—

Moisture at 100° C.	nil
Combined water	·35
Silica	61·75
Alumina	20·74
Ferric oxide	·66
Manganous oxide	trace
Lime	·30
Magnesia	·17
Potash	14·84
Soda	1·07
Sulphuric anhydride	trace
	100·38

Although large quantities of felspar of the above quality are apparently available, its inaccessibility and distance from a market renders it of no economic importance at the present time. It is to be hoped, however, that the future expansion of the ceramic industry will not be restricted owing to an apparent lack of a local supply of felspar.

Deposit No. 5.—Three and a Half Miles West of Kootingal Railway Station.

This deposit is situated in the parish of Moonbi, county Inglis, 3½ miles west of Kootingal, a railway station on the Northern line, 295 miles from Sydney. The writer is indebted to Mr. E. C. Andrews, B.A., F.G.S., geological surveyor, for the information regarding this occurrence, which is being prospected for scheelite and molybdenite. The felspar occurs in pegmatite veins, varying in width from 8 inches to 2 feet, the lengths of which have not yet been determined. The veins consist of felspar and cairngorm in about equal proportions, and pass here and there into an elvan.

Occasional blebs of quartz are associated with the felspar, also flakes of white mica, but iron-bearing minerals are not noticeable in the samples examined. The spar is crystallised and fresh, with a flesh-coloured tint, and on firing yields a good, white, semi-transparent glaze.

Mr. W. Betts, of Kootingal, holds a mining authority over the deposit at present, and although the quantity of spar available appears limited, its quality and proximity to the railway should prove attractive to users.

* Annual Report, Dept. of Mines, p. 51. Sydney, 1893.

Digitized by Google

The following analysis, made in the Laboratory of the Department of Mines, indicates the general composition of the felspar in these deposits :—

Analysis.

Moisture at 100° C.	0·17
Water above 100° C.	0·32
Silica	66·06
Alumina	18·84
Ferric oxide	absent
Ferrous oxide	0·36
Manganous oxide	0·01
Nickel and cobalt oxides	absent
Magnesia	0·08
Lime	0·18
Soda	2·57
Potash	11·70
Barium oxide	absent
Strontium oxide	.....
Titanium dioxide	absent
Iron Pyrites ($Fe. S_2$)	absent
Phosphoric anhydride	trace
Vanadium oxide	absent
Chromium sesquioxide	absent
Sulphur trioxide	absent
Chlorine	absent
	100·29

Sydney : William Applegate Gullick, Government Printer.—1917.

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

J. E. CARNE, F.G.S., Government Geologist.

MINERAL RESOURCES.
No. 27.

THE HILL END TAMBAROORA GOLD-FIELD.

BY

L. F. HARPER, F.G.S.,
Geological Surveyor.

Issued by Direction of the Honorable J. C. L. Fitzpatrick, M.L.A., Minister for Mines.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1918.

[1s. 7d.]

† 36579—a

Digitized by Google

Science Library
TN
122
.N421
A3
no. 27

Digitized by Google

New So. Wales Geol. Surv. Science Library
ep. 6-30-54
12-10-1923

LETTER OF TRANSMITTAL.

Geological Survey, Department of Mines,
Sydney, 8th October, 1918.

Sir,

I have the honor to submit for publication No. 27 of the Mineral Resources Series on the Hill-End–Tambaroora Goldfield, by Mr. L. F. Harper, F.G.S., Geological Surveyor.

This area received much attention in the early days of gold-mining, supported a population of 30,000, and yielded an estimated 50 tons of gold.

It is hoped that the detailed work that has been carried out by Mr. Harper will lead to revival of mining on this historic field.

I have the honor to be,
Sir,
Your obedient Servant,
JOSEPH E. CARNE,
Government Geologist.

The Under Secretary for Mines.

Digitized by Google

Digitized by Google

CONTENTS.

PAGE.

CHAPTER I.—Introduction and acknowledgements. Previous Reference. Historical 1

CHAPTER II.—Physiography. General Geology. Tectonics..... 17

CHAPTER III.—Detailed Geology 23

A. Ordovician.
B. Devonian (?).
C. Post-Devonian intrusions.
D. Tertiary lava flows.

CHAPTER IV.—Early History of the various claims. Modern Mining Companies, and recent mining operations, with suggestions as to future prospecting work 34

CHAPTER V.—The Reefs. Origin, types, characteristics and structure, gold occurrences, faulting "indicators," &c. Alluvial Gold Mining. Summary..... 57

Digitized by Google

Digitized by Google

INDEX.

	PAGE.
Alluvial Gold Mining	72
Altitude of Hill End	1
Amalgamated Hill End Gold Mining Company	13, 51–54
Anticlines	19, 30
Bald Hill	18, 32, 33
Beyers and Holterman	10, 37, 41
Black Watch	45
Breccia	24, 25
Britannia	46
Brown's	39
Cambage, R. H.	2
Canton	45
Card, G. W.	2, 19, 28
Carne, J. E.	1, 2
Carroll and Beard	37
Carver's Reef	43
Claims	34, 56
Cock, E.	2, 53
Contact Zone	24–25
Contemporaneous Lavas	28
Cremorne	46
Deep Levels Hawkins Hill Gold Mining Company	13, 51
Detailed Geology	23–33
Devonian Beds	19, 26–30
Dip Devonian Beds	19, 29
„ Ordovician „	19, 25, 26
Discovery of Gold in Australia, Correspondence relative to	3, 9
Early History	34–47
Emmet, R.	47, 48, 69, 71
Faulting	67, 70, 72
Fischer and Beards	39
Fitzpatrick, J. C. L.	2
Fitzroy, Sir C. A.	3
Flat Ground	66
Folding Devonian Beds	29–30
„ Ordovician „	25
Fossils	23, 27
Foster's Amalgamated Tunnel	34
General Geology	18–19
Gold Yields	Table A, 11, 41–42
Golden Belt	47
Golden Gully Line	45
Goldenville Claim	39
Goodwin, E.	2
Graham, H.	2
Hawkins Hill	10, 11
„ „ Central Gold Mining Company	13, 40, 54–56
„ „ Deep Levels Gold Mining Company	14, 54
„ „ Reefs	35
„ „ Reward Gold Mining Company	13, 43, 47–51
Herman's Claim	38, 42

Digitized by Google

PAGE.

Historical 9-16
Holterman 11
Independent 46
Intrusions 31-32
Jointing—Devonian Beds 30
Kenny, E. J.... 2
Krohman's 37
Le Massurier, A. 2
Magnet 46
Marshall, Messrs. D. and W. 2
,, A. W. 7, 11
,, Hill End Gold Mining Co. 13, 53
Mines and Mineral Statistics 3
Monkey Hill 1
Monte Christo 39, 41
Ordovician 19, 23-26
,, Cleavage... 26
,, Dip of 25
,, Strike 26
Patriarch 40
Paxton's 37-41
Physiography 17 18
Pittman, E. F. 3, 4, 13
Porter and Rawsthorn's 39
Previous Reference 3-8
Prospects 36, 50, 54, 56, 74
Prospecting Suggestions 5-7, 14-16, 49-50, 54, 56
Recent Mining 47-56
Red Hill 46
Reefs, Age of... ... ...21 22
Characteristics 57-70
Fissure veins 58-70
Genesis 57
Saddle 67, 68
Types 58
Reef-mining in Australia, The first 9, 10
Rose of England 40, 41
Sargent's Hill—Plate IV. 10, 44, 45
Scandinavian 5, 43
Sills 21, 31
Silurian 19, 20
Star of Peace... 36
Strike—Devonian beds 29
Ordovician 25
Summary 73-74
Synclines 19, 29-30
Table of Claims 41, 42
Tambaroora 1, 18, 28
Tectonics 20-22
Tertiary Lava Flows 18, 22, 32-33
Unconformity 19, 23-24
Valentine 47
Various Veins 34-56
Watt, J. A. 4, 5, 32
Wyagdon 1

Digitized by Google

Digitized by Google

Frontispiece.

PLATE I.

The famous Beyers and Holterman's "Nugget." Recovered from the Mica Vein at a depth of about 130 feet from the surface.

Digitized by Google

CHAPTER I.

INTRODUCTION AND ACKNOWLEDGMENTS.

The Hill End or Hill-End-Tambaroora Gold-field, as it was known officially, was the scene of the first reef-mining in Australia.

The village of Hill End is situated 53 miles by road north-west of Bathurst, an important town on the western railway system of the State, 148 miles from Sydney. A tri-weekly motor service connects with the railway, and although Hill End is about 1,000 feet above Bathurst, there is an excellent road, and only two pronounced ranges to cross, namely, Wyagdon and Monkey Hills. The former is the divide between the waters of the Macquarie River and its tributary, the Turon, whilst the latter rises from the Turon River to the Hill End Tableland, with a general altitude of about 3,000 feet.

Hill End and its environs, a few years after the first rush, had a population of some 30,000 people, including Chinese, and boasted of fifty-two hotels, whilst five banks were kept very busy—in fact, it was not an uncommon occurrence for sacks of rich gold-bearing quartz to be dumped in the backyard of the bank premises until accommodation was available. Now two hotels supply the wants of the thirsty few and accommodate the weary traveller; whilst, apart from the Government Savings Bank, there are no branches of the banking institutes, and the dismantled or vacant houses almost outnumber the habitable ones.

Tambaroora lies about 3 miles north of Hill End, but in the boom days the two towns were practically joined up by isolated residences. The village of Tambaroora has fallen upon evil times of late years, however, and is now devoid of even one hotel or boarding-house, whereas these used to be counted by the score. It is situated on the main road from Mudgee to Hill End, being distant some 41 miles from the former town, with which it is connected by a tri-weekly coach service *via* Hargraves, another old mining settlement about 18 miles north of Tambaroora.

Practically the whole of this belt of country was held in the early "fifties" as a cattle run by a Mr. Cummins, with a head station at Peel, some 10 miles from Bathurst. The property subsequently passed into the hands of Miss Eadith Walker, of Concord.

ACKNOWLEDGMENTS.

In September, 1916, Mr. J. E. Carne, F.G.S., Government Geologist, accompanied Mr. Estell, at that time Minister for Mines, on a visit to the Hill End Gold-field, and in support of suggestions made to the Minister, Mr. Carne strongly urged the necessity of a detail geological survey of the field. He also made strong representations regarding the importance of continuing the Amalgamated tunnel further north, with a view to draining a large portion of the field, and thus facilitating mining operations for the individual claim-holder or company.

Digitized by Google

The present Minister for Mines, Mr. J. C. L. Fitzpatrick, visited the Hill End district during 1917, in company with Mr. R. H. Cambage, Under Secretary for Mines, and in response to solicitations from those interested in the field, it was decided that a comprehensive geological survey should be made, in the hopes of securing evidence that would assist the mining industry.

Mr. J. E. Carne entrusted the writer with this work, and, in addition to visiting the field on a preliminary reconnaissance, and again in the completion of the survey, kept in touch with the work throughout.

Mr. G. W. Card, A.R.S.M., Mineralogist to the Geological Survey, examined the numerous rock and lode specimens collected during the survey, and is responsible for the petrographical information, in addition to affording much useful information regarding hand specimens of both rocks and minerals.

Mr. E. J. Kenny, Field Assistant, was associated with the field work for about two months, and by his enthusiasm and keen discussion of the various problems met with, rendered valuable aid throughout.

Messrs. D. and W. Marshall, residents of Hill End, and most enthusiastic as regards the progress of the field and the problems it presents to the mining man, rendered valuable assistance. Their intimate local knowledge, both as regards structural geology and early mining, was a constant help, and the keen grasp and pertinent discussions of problems met with or theories advanced proved most helpful.

Mr. D. Marshall devoted much time to showing the writer over the field and mine workings, and the final crystallisation of the theories advanced and solutions offered owe much to his desire to know the reason and evidence in every case.

Mr. Harry Graham, a resident of Hill End, who first went to the field in 1868, and was for many years actively engaged in mining operations, proved an inexhaustible source of information, particularly as regards conditions in the old abandoned workings. His keen powers of observation enabled him to afford very reliable information, and his grasp of mining or geological problems on this field was most helpful, their discussion proving a source of interest and amusement, owing to his sense of humour and flow of language. Mr. Graham kindly supplied much of the historical data, and although dependent entirely upon his memory, there is every reason to believe that his statements are fairly correct.

Mr. E. Cock, manager for the Hill End Amalgamated Company, in addition to affording useful underground information, supplied all the mine working plans from his own surveys.

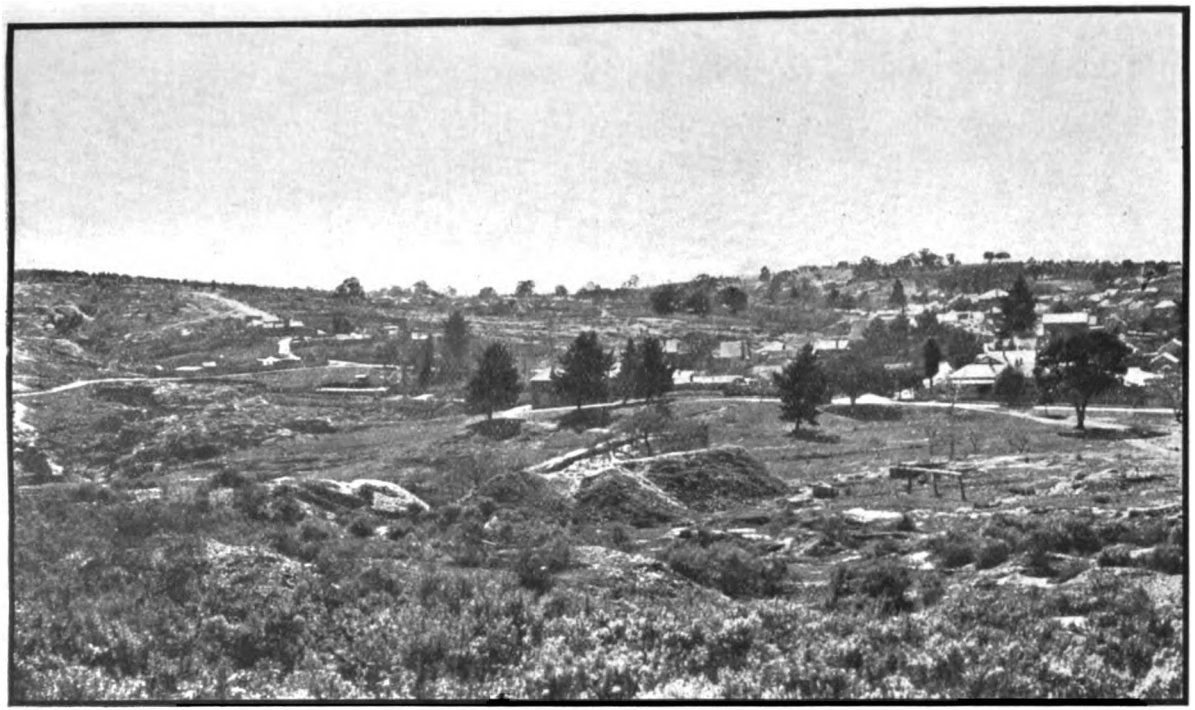
Mr. E. Goodwin, manager of the Reward Mine, was a most willing helper throughout, and, in addition to saving a number of interesting structural specimens from the mine workings, readily grasped the solutions offered for various problems, and put them to practical tests underground, thus assisting greatly in the final conclusions arrived at in this publication.

Mr. A. Le Messurier, one of the oldest living residents of Hill End, kindly supplied information regarding the early days of the field, and the photograph from which Plate I was prepared.

To enumerate all who were ready to afford information and assistance is hardly necessary, but the writer would like to take this opportunity of expressing his sincere appreciation of their help.

Digitized by Google

PLATE II.



The village of Hill End, 1918, looking north. The dump heap in the foreground is from the old Scandinavian shaft.

Digitized by Google

Digitized by Google

Digitized by Google

During the year 1879, Mr. E. F. Pittman, late Government Geologist in New South Wales, and at that time a Government Geological Surveyor, made an examination of the Hill End-Tambaroora Gold-field, and prepared a geological map of the area, accompanied by a short report (notes) thereon. The map and notes were published in the Annual Report of the Department of Mines for 1879, together with a set of mine plans and sections prepared by Mr. T. S. Parrott, C.E., &c.

The map and report make no allusion to a differentiation in age of the sedimentary rocks, but this no doubt is due to the lack of evidence available at that time. The characteristic features of the rocks representing the various geological periods found in New South Wales were not then known, and moreover petrology had not reached a stage which would enable a strict line to be drawn between certain fragmental rocks and those of direct igneous origin.

In the light of present-day knowledge it is conceivable that the conglomerates alluded to in Mr. Pittman's report may in part be referable to the tuffs and arkose rocks so pronounced in the Hill End District, which do certainly assume a conglomeratic type in places, due to the incorporation of rounded fragments of slate, &c.

In the presence of the arkose rocks and tuffs it is hardly to be wondered at that the occurrence of contemporaneous lava flows was not recorded, for in the field a differentiation is rendered very difficult.

A series of articles on "The Hill End Gold-field" were published in the *Sydney Morning Herald* during January, 1880.

During the same year an interesting booklet was prepared[1] in connection with an amalgamation scheme between several claims on Hawkins Hill. As far as is known only one copy of this publication is now available in New South Wales, and is in the possession of Mr. W. Marshall, of Hill End, but copies of the *Australian Magazine* for June, 1880, from which it was reprinted, should be procurable. Much of the information contained is invaluable to those interested in the field, dealing as it does with the amount of work done on numerous claims, yields, &c. Some of the information is incorporated in the table given on p. 42.

In 1898, Mr. E. F. Pittman, A.R.S.M., at that time Government Geologist in New South Wales, again visited the field and furnished a report[2] upon the possibility of prospecting the Hill End field by means of the diamond drill. Mr. Pittman deals at some length with the nature of the reefs, and points out that the Hawkins Hill veins are not of saddle formation, but must be classed as bedded reefs only.

In this report reference is made to the Emmet and Hughes crosscourse, the nature of which the present writer was unable to investigate owing to the old workings being under water.

During the same year[3] Mr. J. A. Watt, at that time a Government Geological Surveyor, also visited Hill End, with a view to reporting upon the best means to prospect for the lost reefs.

Mr. Watt undoubtedly identifies the Devonian saddle reefs (see pages 174-6, Annual Report), but apparently saw no evidence which would lead him to differentiate the Ordovician bedded reefs (pages 58-66). He also appears to have come to the conclusion that "bands of eruptive rock of granitic

[1] "The Star of Peace Gold Mining Company (Limited), Hawkins Hill," Jarrett & Co., 100 Liverpool-street, Sydney, 1880.

[2] Annual Report Dept. of Mines, Sydney, 1898, pp. 181-2. [3] *Ibid.* pp. 176-8.

Digitized by Google

Digitized by Google

Digitized by Google

composition, which passes in places into a fine-grained felsitic variety," were intrusive sills. This is borne out in at least three instances by the recent geological survey, but it is also evident that there is an extensive development of tuffs and arkose rocks with associated contemporaneous lava flows.

In 1899[1] Mr. Pittman visited Hill End and came definitely to the conclusion that some of the rocks in that district were of igneous origin.

During the year 1900 Mr. Pittman again visited Hill End in connection with the proposal to grant aid from the Government Prospecting Vote to prospect the Hill End lodes. His report, published in the Annual Report of the Department of Mines for 1900, pages 177 and 178, is here given in full, in order that the various schemes put forward may be considered in the light of present-day evidence.

> "Report on the proposed aid to prospect Hill End lodes at a depth.
>
> "The accompanying plan and sections of Hawkins Hill, Hill End (from Mr. M. S. John Thomas's surveys), have been made with the object of illustrating the various proposals for prospecting the gold-bearing veins at a depth with the assistance of aid from the Prospecting Vote.
>
> "The proposal made to the Minister on the occasion of his recent visit to Hill End was that the Government should assist to drive in a northerly direction for about 2,300 feet from the end of the amalgamated tunnel. In my opinion there are two serious objections to this scheme; viz.:—
>
> "(1.) Owing to the fact that the direction of the proposed drive would be nearly at right angles to the amalgamated tunnel, and that the latter is nearly 1,200 feet long, there would be very great difficulty in ventilating the proposed drive.
>
> "(2.) Even if the proposed drive were successfully constructed, the gain would not be in any way proportionate to the cost of construction, inasmuch as it would not be at a sufficient depth. According to barometric observations made by me, the amalgamated tunnel mouth is 820 feet lower than the mouth of the old Star of Peace shaft. I find that the Star of Peace shaft, according to Mr. Mining-Surveyor Parrott's survey, has a total vertical depth of 720 feet, so that the amalgamated tunnel is only 100 feet below the limit which has already been prospected by the Star of Peace shaft; and there can be no question that the cost of constructing such an expensive drive as the one under consideration would be altogether too great, in view of the fact just stated, viz., that it would only prospect the reefs for a maximum depth of 100 feet lower than they have already been worked. Moreover, the proposed drive would be wholly in land which has been held for mining purposes for the last twenty-three years, but on which there has been very little legitimate prospecting work done. The drive would undoubtedly enable the holders of this land to work the deposits, which they have succeeded in holding for so many years, at a minimum of cost, but comparatively few people would benefit by the Government subsidy, and the work would

[1] "Notes on the Geology of the Hill End Gold-field," by E. F. Pittman, A.R.S.M., Government Geologist: Records Geological Survey of New South Wales, 1899. Vol. VI, part II, pp. 81-82.

Digitized by Google

in no wise settle the question as to whether the rich gold-bearing deposits extend into the Crown lands to the east. As, in my opinion, the only justification for the Government undertaking the costly work of prospecting the reefs at a depth would be the benefiting of the community generally, rather than a few individuals who have monopolised the land without vigorously working it, I cannot recommend that the proposed drive be aided.

"The question then arises what other scheme can be suggested which would give better results for the expenditure of Government money. There are five other schemes, which will now be discussed. They are—

"1. Continuing the old tunnel shown at C on plan herewith, for a further distance westward of about 1,500 feet, as proposed by Mr. George Vere. The objection to this scheme is that it would not prospect the veins at as deep a level as they have already been worked in the Star of Peace shaft.

"2. Putting in a westerly tunnel from Boogong Creek, on the eastern side of Hawkins Hill, opposite the amalgamated tunnel. Judging by Mr. Mining-Surveyor Thomas' section and the dip of the reefs shown thereon, this tunnel would require to be about 1,850 feet long before it would intersect the reefs. The objection to this scheme also is that it would only prospect the deposits about 100 feet lower than they have already been worked.

"3. To drive northward along the lode formations from the bottom of Hawkins Hill, near the Turon River, as suggested in a letter written by Mr. D. Kirkwood. The principal objection to this scheme is its great cost, as it involves driving for a distance of at least 1 mile or possibly 2. At the same time, outside the question of expense, it must be admitted that it would be the most satisfactory as well as the most comprehensive method of prospecting the disposits. It will be observed that Mr. Kirkwood states that the proposal emanates from a powerful English syndicate, and that there is a possibility of its being carried out, provided sufficient land can be obtained. The fact of such a syndicate being in communication with the holders of the land on Hawkins Hill, with a view to prospecting the deep levels, raises the question as to whether there is really any necessity for the Government to undertake this work at all. I feel satisfied that the deep deposits of Hawkins Hill can only be successfully worked by a powerful company, for the necessary operations will require a very considerable amount of capital, and if a syndicate be ready to undertake the prospecting of these deposits, it is doubtful whether any good purpose would be served by the Government doing it for them. Mr. Kirkwood's letter, which is submitted herewith, is, at any rate, deserving of some consideration in this connection.

"4. To continue sinking the Star of Peace shaft a further depth of 500 feet. According to Mr. Parrott's survey, this shaft is vertical for a depth of 212 feet, and then follows the underlay

Digitized by Google

of the reef for about 550 feet more, making a total depth of 720 feet (vertical) from the surface. If this proposal were adopted it would, of course, be necessary to put the shaft in repair before sinking operations could be continued. The main objection is again the fact that the scheme would only benefit the present holders of the leases on Hawkins Hill, and these persons have not shown themselves worthy of special consideration, inasmuch as they have not carried out any vigorous prospecting operations.

"5. The only other scheme which suggests itself to me is to sink a deep vertical shaft on the Crown lands to the east of the leases which have been held for so many years. At the point X, shown on Mr. Thomas's plan and section, such a shaft would probably require to be sunk to a depth of 1,250 feet before it would intersect the Hawkins Hill lodes. This depth is undoubtedly considerable, and the cost, which would be great, would probably have to be borne by the Government alone. At the same time it appears to me that this scheme is the only one, with the exception of scheme No. 3, under which anyone, outside the holders of the present leases, would be likely to benefit directly by the Government aid, if the prospecting resulted successfully.

"To summarise, scheme No. 3, involving a tunnel from near the Turon River, northwards under Hawkins Hill, would be the most effective for thoroughly prospecting the auriferous reefs at a depth. Its cost would, however, be very great, as the tunnel would have to be driven for a mile or more. Of the other schemes, No. 5 would be the next best for carrying out the intentions of the Government, if, as I assume, it is not intended to benefit merely a few people who have been holding the land for years. This scheme would also cost a large sum of money.

"I have, &c.,

"E. F. PITTMAN,

"Government Geologist.

"The Under Secretary for Mines and Agriculture."

In 1901 Mr. Alec. W. Marshall, Associate Institute of Mining and Metallurgy, London, had a paper published in the Proceedings of the Society, which deals in considerable detail with the Hill End field. Mr. Marshall had access to most valuable information concerning the mine workings on the field during its early days (1870-1875), and his contribution is most valuable, for he was in a position to describe conditions in the old workings, access to which is not now available.

The present writer has quoted from this work when appropriate, and also reproduced certain diagrams and sections.

Mr. Marshall appears to have held the view that the reefs were in the nature of saddle formations, but this is not to be wondered at, seeing that he had no concrete geological knowledge regarding the lithological characteristics of our various geological periods.

Digitized by Google

In the "Mineral Resources of New South Wales"[1] Mr. Pittman refers at some length to the Hill End field, and it is clear that his views at that period were much more defined than is evidenced by his earlier reports.

The occurrence of beds of tuff and intrusions of quartz porphyry are referred to, and an Upper Silurian age is assigned to the sediments, whilst the presence of a pronounced anticline is pointed out. The structure of the reefs is discussed and their bedded nature in the "black slates" described, whilst the occurrence of auriferous reefs "at the junction between the slate and a sill or bed of volcanic tuff" is noted.

An interesting article on the field appeared in the *Town and Country Journal* for 28th December, 1904.

In 1909 the present writer contributed a paper to the Geological Survey Records[2] entitled "Notes on the Physiography and Geology of the North-eastern Watershed of the Macquarie River." This was the result of an extended examination of the areas of Gold-field Reserves in that district, with a view to their curtailment, and no pretence was made of a geological survey.

In this paper the presence of contemporaneous "Silurian" lava flows is touched upon, also the great development of tuffs, whilst the possibility of two geological periods (referred to as Silurian and Ordovician) being represented in this locality is pointed out.

Early in 1912 a report was furnished by Dr. C. A. Mullholland to the Directors of Hawkins Hill Reward Gold Mining Company, but the report deals more particularly with the specified mining property.

During 1912 Mr. W. H. Cundy, Mining and Geological Surveyor, reported at some length upon the field. Particular attention is paid to the presence of saddle reefs, but Mr. Cundy apparently did not identify two ages of sedimentary rocks, nor the presence of unfolded true bedded reefs.

The writer realises that in putting forward the views expressed in this work there is still much to be desired in the way of confirmatory evidence, and it is to be hoped that future developments on the field will help to place the situation beyond doubt.

Much desirable and highly-important evidence is not available for the purposes of drawing conclusions or deductions owing to the impossibility of examining almost all the old workings. In consequence, the difficulties of expressing a decided opinion upon many points were greatly increased, but every effort was made to obtain confirmatory evidence in support of deductions drawn with regard to occurrences which could not be examined.

Two typical instances may be given in regard to this, namely, the probability that the Robert Emmet, or Emmet and Hughes, "cross course" is in part on the contact zone, and that Rowley's reef occupies the western leg and trough of a true inverted saddle occurring in rocks of a more recent age than the main Hawkins Hill reefs.

---

[1] E. F. Pittman, Government Geologist, Sydney, 1900, pp. 31–33.

[2] 1909, vol. VIII, part IV, pp. 321–324.

Digitized by Google

HISTORICAL.

Alluvial gold was first found in this belt of country during the year 1851 by prospectors who worked their way across from The Ophir, on the opposite side of the Macquarie River, where the first alluvial gold-mining in Australia had started some few months previously.

About the same period saw the alluvial miner tracing the gold from the Mudgee side to the south of Hargraves (Dirt Holes Creek), and as the first-comers from either end drew closer, there was a natural desire to explore the intervening country. One of the earliest parties of prospectors, on mounting the east and west divide at Hill End, now known as Sargent's Hill, looked north down on a valley which was ablaze with wattle blossom (*Acacia dealbata*) and, possibly influenced more by the fever for the precious metal than by poetical inspirations, they christened it Golden Gully, little dreaming that it was subsequently to be proved a golden gully in reality.

As they passed by what was afterwards the site of the village of Tambaroora they saw a couple of police troopers and a black-tracker pitching camp, but their objective was the Dirt Holes Creek rush, and they did not stop. Not being able to secure claims there, they started back again a day or two later, and on reaching the police camp were astonished to see hundreds of miners busily at work on rich auriferous drift.

It appears that the black tracker, in loosening the ground for a tent post-hole, had unearthed a fair-sized nugget of gold, and hence the mining activity.

Prior to this period there does not appear to have been any laws governing the winning of gold, but in a Government Gazette published in May, 1851, a notice was issued prohibiting gold-mining without a license, the fee for which was fixed at £25.

In a despatch from Sir C. A. Fitzroy (at that time Governor-General of the Colony) forwarded to Earl Grey, Secretary of State, on 11th June, 1851, the following appears:—[1]

> "I therefore trust that the system of licensing which has been adopted will meet your Lordship's approval. It is obvious that this system can only apply to *digging* for gold. Whenever it may have to be extracted from the matrix by mining, as will no doubt be the case at some future and probably no distant period, capital, machinery, and skill, as well as labour, will be required, which can only be employed to advantage by companies or individuals possessing the former requisite; and when that period shall arrive the mines can be leased or placed on such a footing as may be deemed most advantageous to the Crown and to the Colony."

From the foregoing it is apparent that no titles for "reef" or "gold in matrix" mining, as it was termed, could be obtained for the first few months after the discovery of gold.

This bears out the following information gathered from residents of Hill End, who were either there in the very early days or had the information handed down to them.

---

[1] Correspondence relative to the Discovery of Gold in Australia, London, 1852. No. 101, p. 9, par. 12.

Digitized by Google

Between the years 1851 and 1852 it is stated that a miner named Collison, who had been surreptitiously dollying quarts specimens containing coarse gold obtained on Sargent's Hill, and hammering out his winnings to resemble alluvial gold, had an interview with a Mr. Sargent, solicitor in Bathurst, who brought the matter before the authorities and obtained the right to mine for "gold in matrix," the extent of his "claim" being from the Turon River to the Dirt Holes Creek, a distance of nearly seven miles, with apparently no limit as to width The syndicate or company formed brought out Cornish miners to work the property and ordered a battery from England.

Thus it would appear that Sargent's Hill, Hill End, was the site of the first reefing claim in Australia. The ground now known as "The Old Company's," some 2 miles north of Tambaroora, was prospected by this company, as well as Sargent's Hill, which lost favour before the arrival of the plant. Consequently the first stamper battery in Australia was erected about 2 miles north of Tambaroora in the year 1857.

Prior to this the only method of winning gold from its matrix was by pounding it up with hammers, and washing in a gold-saving box known as a cradle. The first stamper battery consisted of a beam engine working fifteen head of stampers, and driven from a Cornish boiler.

During 1855 Rowley Brothers were winning gold from near the crest of Hawkins' Hill by surfacing at a spot discovered by Mr. J. Wythes. Despite the fact that they were getting most gold along a rubbly line of quartz, it was through a Cornish miner, known as Daddy Nichols, that the presence of a reef was detected, and this vein was first worked during 1860.

During 1858 and 1859 several reefing claims were worked along the eastern slopes of Golden Gully, and in the latter year a five-head stamper battery was erected by a Mr. Renetaul, midway between Hill End and Tambaroora. It was at this battery that most of the stone won in the early days from the Golden Valley claims was crushed.

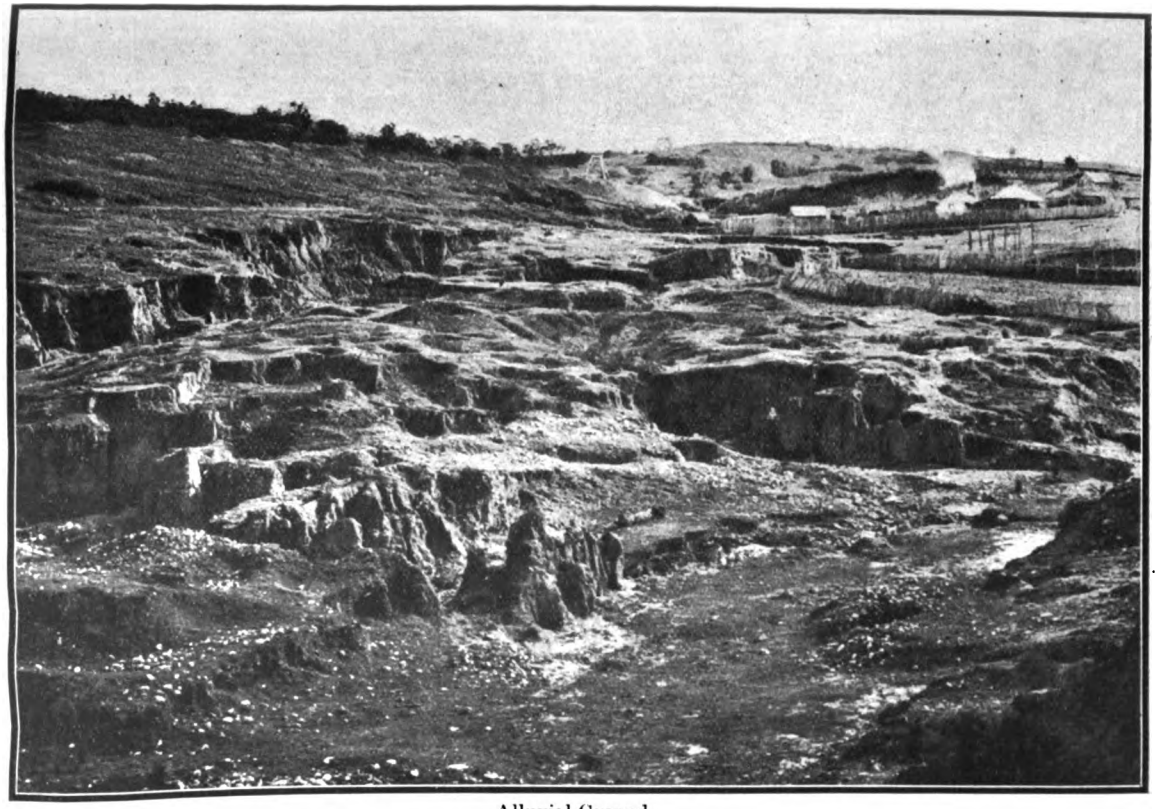
In 1861 a man named W. Adams, whilst rounding up horses, saw the precious metal glittering in a piece of quartz which subsequently led to a reef being located, afterwards known as "The Rose of England." Work on this reef does not appear to have commenced until about 1868, and although it was small, very rich returns were obtained, 1,260 oz.[1] of gold being won from 20 tons of ore. The bulk of the stone was treated at Renetaul's battery.

During the following four years quite a number of claims were opened up on Hawkins Hill, and in 1870 a Mr. Pullen brought a battery from Hargraves and erected it at Hill End. This appears to have been a five-head battery, with its stampers arranged in a circle and operated by a circular cam shaft. Shortly afterwards the same gentleman erected an up-to-date fifteen-head stamper battery a few hundred yards from the present Hill End post office, and crushed a large quantity of rich ore from the field.

For about six months in the early part of 1870 there appears to have been a slump, and claims could have been purchased for a mere song. Before the close of the year, however, fresh developments led to a bigger rush than ever, and most startling gold discoveries were made. Towards the close of 1871, the famous Beyers and Holtermann's "nugget" was unearthed from the bottom of a shaft about 130 feet deep. This mass of gold was actually

[1] A. Marshall "Hawkins' Hill and Hill End." Inst. of Mining and Met., London, 1901, p. 2.

Digitized by Google



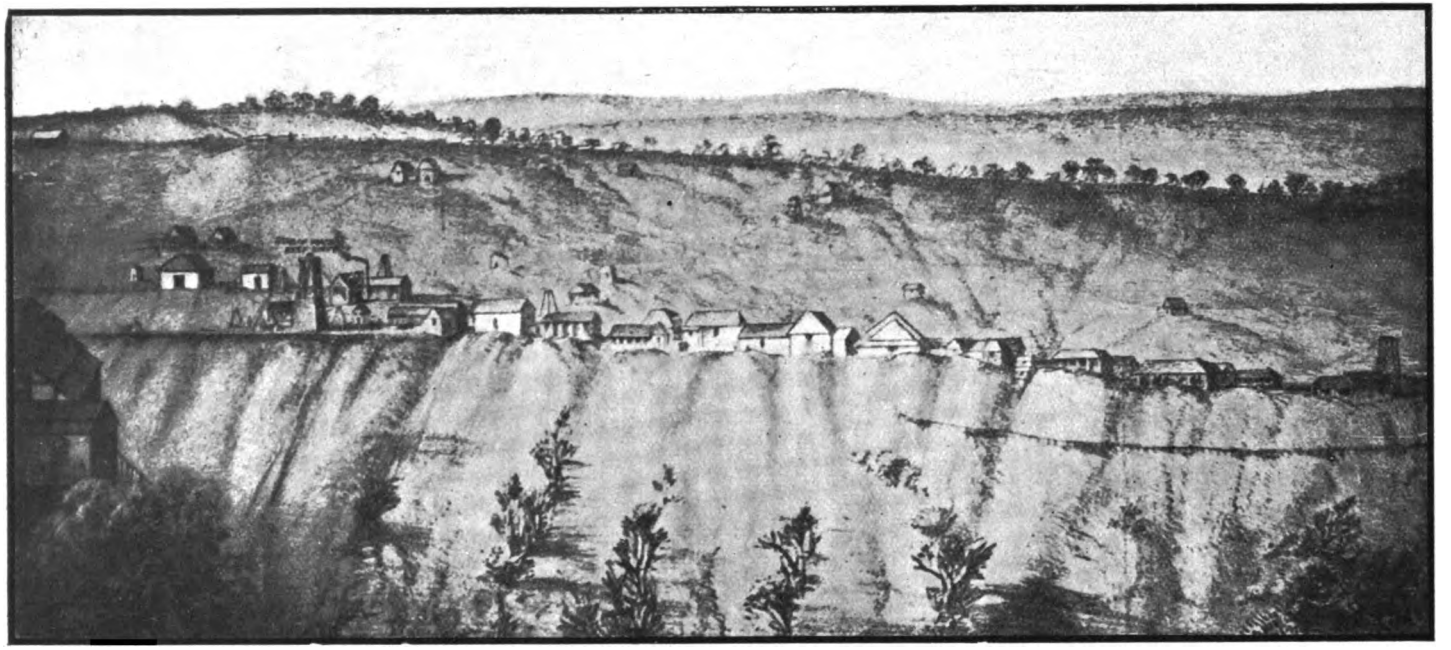
Alluvial Ground.

Specimen Gully on left, Hill End Creek to right. The best exposure of the unconformable contact between Ordovician and Devonian (?) sediments occurs in a cut on the extreme right centre. Sargent's Hill is seen about the centre of the horizon.

Digitized by Google

Digitized by Google

Digitized by Google



Star of Peace Battery.	Fisher and Beards.	Star of Peace.	Paxton.	Rampant Lion.	Hickson and Beards.	Cock, Attwood, and Dwyer.	Porter and Rawsthorne's.	Brown's.	Monte Christo.	Beyers and Holterman's.	Krohmann.	Carroll and Beards.
Gold produced from various mines ...	£41,000.	£68,862.	£128,000.	£27,000.	£47,000.	£40,000.	£40,000.	£50,000.	£35,000.	£130,313.	£203,760.	£57,000.

Hawkins Hill, Hill End during 1871.

Practically each building represents a "claim," worked either by shaft or tunnel. Compare with Plate VIII, the central portion of which covers the same ground.

Digitized by Google

in situ in the Mica Vein, weighed 630 lb., and had the following dimensions:—Height, 4 ft. 9 in.; width, 2 ft. 2 in.; average thickness, 4 in. (See plate I.)

Associated with the gold were small makes of arsenical pyrites, and as it was broken up before smelting and mixed with other gold from the battery its true value is not known, but £13,000 is stated to have been offered for it by an enterprising showman, who intended to tour the world with it for exhibition purposes.

In 1871, a Mr. Chapple brought the "Old Company's" battery from Hargraves, and erected it on the banks of Hill End Creek, about half a mile below the town. About the same time a Mr. Vickery put up a twelve-head stamper battery at the head of Boogong Creek, about half a mile south of the town. It was at this plant that a cake of gold weighing 5,600 oz. was retorted in response to a premium offered by Mr. Vickery for the largest cake of gold from any one claim. Paxton and Holman were the lucky winners, and although the tonnage treated is not now known, there is every reason to believe that it was comparatively small, as there is a record of 2 tons of stone from the same claim having yielded 4,200 oz. of gold shortly afterwards.

At this period there were probably several hundred claims on payable gold, and not less than ten batteries at work on the field, totalling over 100 head of stampers.

The most successful mining appears to have been carried out upon Hawkins Hill from 1870 to 1872, but fell off during 1873, after which no sensational finds appear to have been made.

Mr. Alex W. Marshall, Associate Institute Mining and Metallurgy, London, wrote a paper for the proceedings of that society, published in 1901, in which he records the following returns from some of the earlier Hawkins Hill claims:—

> "The fact that the whole hill was divided up into very small claims prevented anything like complete plans or records being preserved. Still a few kept their accounts fairly well for a time. From seven claims, the largest 120 feet and the shortest 37 feet on the line of veins, the following returns were got in 1871-1872:—
>
> "Brown's, £50,000 worth of gold.
> "Holtermann's, £130,000 worth of gold; dividends, £107,000.
> "Krohman's, £203,000 worth of gold; dividends, £177,000.
> "Star of Peace, £57,000 worth of gold.
> "Carroll's, £70,000 worth of gold; dividends, £39,000.
> "Hickson's, £50,000 worth of gold."

Mr. Marshall goes on to state that—

> "Additional gold was taken from other claims, and bank returns show that between 1869 and 1875, over £1,200,000 worth of gold was won from this spot.
>
> "More individual fortunes, ranging between £10,000 and £60,000, were taken out of Hawkins Hill than from any other goldfield in New South Wales."

Some of the early returns published by Mr. Marshall are—

> "Holtermann's Claim, 150 tons, yielded 15,000 oz. of gold; Krohman's Claim, 139 tons, yielded 13,390 oz. of gold; Krohman's Claim, 16 tons, yielded 5,612 oz. of gold."

Digitized by Google

According to Mr. Marshall, "About a dozen veins in Hawkins Hill have been worked. They are all small—the best was under 6 inches thick; sometimes when they thickened to 12 or 15 inches they were payable, but very rarely."

Large masses of quartz called "blows" also yielded some rich returns, but from the particulars available it seems reasonable to assume that by far the largest quantity of gold was won from the narrow veins.

At the Prince Alfred Park Exhibition, held in Sydney during 1871, a cake of gold containing 24,000 oz. was exhibited, the gold having been retorted from crushings made from Herman's claim.

The *Mining Register* at Hill End during 1875 reported that—

> "Of the hundreds of claims started in this division during the last five years, the following only are now at work on Hawkins' Hill:—Carroll and Beard's, Krohman's Rawsthorne, Star of Peace, Paxton's, Monte Christo, Cock and Attwood and Dwyer, Beyers and Holtermann's, Herman's, Mathewson's, Hickson, Creighton and Beard's and Brown's, the latter three of which are on tribute,"

whilst he reports six claims at work in the immediate vicinity of the village of Hill End.

In 1877 the *Mining Register* again reported that the rich veins worked in Paxton's mine were picked up in the Star of Peace mine, about 20 feet from the former Company's boundary, and at the 160-feet level, and a crushing of 28 tons gave a return of over 10½ oz. per ton.

A map published by the Department in 1877 shows 112 leases in force, but there is no doubt that a number of these never were payable, many of them having been taken up for flotation purposes. In the year 1884 mining operations were very stagnant, and a wealthy English company, headed by the Duke of Manchester, who visited the locality personally, secured the mining rights over a considerable area. Operations were not successful, however, and the company was reorganised with the help of Colonel North. Under the superintendence of that gentleman, a vigorous development policy was inaugurated, the Patriarch shaft being sunk vertically to a depth of 500 feet. A Mr. W. H. Collins was brought out from England to sink Vickery's shaft to a depth of 1,000 feet, but meanwhile Colonel North died, and the company went into liquidation in 1898.

On the 2nd November, 1898, the Executive Council approved of a recommendation by the Prospecting Board to reserve from mining lease an area 1 mile long by ½ mile wide in the neighbourhood of Hill End. This was done in order to prevent individual claim-holders from exploiting the ground at the expense of any company prepared to undertake a comprehensive prospecting scheme.

Messrs. Kirkwood and Company, who represented a syndicate prepared to prospect the deep deposits, appear to have been disposed to carry it out. Nothing came of the suggestion, however, the enormous cost apparently standing in the way, and the scheme lapsed.

During the year 1900 interest again revived in regard to the Hill End gold-field, and various proposals were considered for prospecting the gold-bearing veins at a depth with the assistance of aid from the Prospecting Vote.

Digitized by Google

In the Annual Report of the Department of Mines for 1900 (pp. 177-8), Mr. E. F. Pittman, A.R.S.M., at that time Government Geologist, dealt in detail with five schemes for prospecting the field.

The proposal to drive a long tunnel starting from the foot of Hawkins Hill and extending northwards along the course of the veins is most favoured in Mr. Pittman's report.

In February, 1911, the prospectus was issued of a company entitled Amalgamated Hill End, Limited, with a capital of £100,000 in 500,000 shares of 4s. each, the area taken over for gold-mining purposes being considerable. This Company started operations shortly after the above was issued, and continued a vigorous development policy up to the end of 1917, when funds began to run short.

As stated on page 53, there is no doubt as to the value of the work done by this company as far as the gold-mining belt is concerned, but lack of detailed information, or a comprehensive geological opinion of the field, appear to have greatly handicapped successful operations.

The Hawkins Hill Reward Gold Mining Company was formed during 1912, with a capital of £20,000 in 80,000 shares of 5s. each. Some 28 acres of ground were secured, and mining has been carried on by the Company up to the middle of 1918, when a reconstruction and amalgamation took place.

The Hawkins Hill Central Gold-mining Company was formed during 1915, with a capital of £37,000 in 250,000 shares of 3s. each. About 74 acres of land were secured originally, but this has subsequently been added to.

Up to the time this publication was prepared, the Company had devoted most of their efforts to driving the Amalgamated tunnel through the property for unwatering purposes. This is now nearly completed, and it is proposed to continue sinking the excellent three-compartment shaft (vertical from its present level (500 feet) to connect with the tunnel, 150 feet beneath.

During 1918 there was an almost general exchange of interests amongst the principal mining properties.

In March the Amalgamated Hill End Company disposed of their interests to Marshall's Hill End Gold Mines. The capital of this Company is £15,000 in 75,000 shares of 4s. each. The original Company retained a tribute right to work the Star of Peace and Mica Vein series below the Amalgamated tunnel level.

The new Company are at present devoting their energies to pushing on the Amalgamated tunnel north towards the Deep Levels Hawkins Hill Company's leases, through the Hawkins Hill Central Company's ground, and to prospecting the various reefs by cross-cuts.

It is intended as soon as possible to unwater the old Carroll and Beard's shaft and cross-cuts, and prospect the main veins 300 feet below the tunnel level.

Later on in the same year (June) the Hawkins Hill Reward Company was reconstruted, and an amalgamation arranged with The Golden Key property on the north, and including the old Scandinavian leases.

Digitized by Google

The new company is known as the Deep Levels Hawkins Hill Gold-mining Company, with a capital of £37,500, divided into 100,000 shares of 7s. 6d. each.

It is in this Company's workings that the recent rich make of stone was located by reason of the present geological survey.

At the time of compiling this publication the foregoing three companies represent the principal mining operations on this field. In July, 1918, the Prospecting Board considered a comprehensive scheme for assisting them and the field generally.

The following were the suggestions placed before the board by the present writer:—

The schemes which present themselves as most likely to yield favourable results are as follows:—

1. To prospect the ground at a greater depth under the rich makes of stone formerly won from Hawkins Hill.
2. To prospect for the presence of payable reefs in the Ordovician beds where covered by a blanket of younger Devonian rocks.

Scheme No. 1.

The accompanying plan and section (2) indicate the amount and relative position of the principal prospecting work carried out under Hawkins Hill during the past ten years.

The evidence points to many of the veins and the rich schutes of gold in the upper levels dying out in the vicinity of the Lowel Tunnel (Amalgamated). Numerous new veins have been cut in this tunnel, but up to the present their gold contents have not proved payable.

The question is will these veins be payable if prospected where they attain greater dimensions, and in the neighbourhood of the fault planes or cross courses, as they are termed locally. There is no doubt that the richest makes of stone on the field were all obtained in the vicinity of the cross courses and the attendant fractured country, and as these occurrences are likely to go down, prospects in the new reefs should be most favourable in their vicinity. The diagram on page 52 illustrates the foregoing.

Two opportunities exist for testing these reefs at a greater depth—

(*a*) To continue sinking the shaft known as the Government Shaft (shown on plan 4), which is now down 150 feet below the Amalgamated tunnel, and then cross-cut east and west for 150 feet, from a depth of 300 feet.

(*b*) To unwater Carroll's and Beard's shaft (see plan 4), and extend the existing cross-cut 200 feet further east.

The present depth of this shaft below the Amalgamated tunnel is 290 feet, and cross-cuts 70 feet west, and 164 feet east were previously driven.

With regard to scheme (*a*), it may be pointed out that the shaft is an underlay one, its dimensions being 12 feet by 4 feet 6 inches; also that it is much farther from daylight for trucking out mullock than Carroll's and Beard's shaft.

It would require to be sunk a further 150 feet, and at the total depth of 300 feet cross-cuts should be driven east for 50 feet and west for 100 feet, in order to cut all the reefs.

Digitized by Google

Scheme (b).

Carroll and Beard's shaft is vertical, and its dimensions are 6 feet by 3 feet. The following work would require to be done in connection with this undertaking:—

1. A chamber with roofing to be constructed, in order to divert surface water into the upper tunnel (Consolidated).
2. A chamber over the shaft at the Amalgamated tunnel level to be excavated for the erection of the head-gear.
3. The shaft and old workings to be pumped or bailed out.
4. 200 feet of cross-cutting east from face of existing cross-cut.

The present eastern cross-cut is supposed to have passed through the Amalgamated vein a few feet from the face. This is one of the most westerly veins worked on the central portion of Hawkins Hill, and the object of the cross-cut would be to prove all the series from west to east as worked in the upper levels, and also penetrate the new veins nearly 300 feet below the ground already prospected.

A section (measurements only approximate) of the lower workings from Carroll and Beard's shaft, as supplied by miners who worked there, is as shown on page 52.

Scheme No. 2.

The second scheme is more comprehensive, would be the means of exploiting a large area, and lead to the opening up of new mines if the desired evidence were favourable. It may be outlined as follows:—

1. To sink the Scandinavian shaft (see plan 2) to a depth of approximately 800 feet.
2. To cross-cut from the bottom of the shaft west for 100 feet.
3. Drive south to connect with the Amalgamated tunnel (about 1,000 feet).
4. Continue Amalgamated tunnel north to connect with Scandinavian workings (about 1,000 feet).

This scheme would be the means of permanently unwatering the central portion of the Hill End field, and no doubt the tunnel would eventually be extended under Sargent's Hill if developments justified it.

The Scandinavian shaft is sunk in Ordovician rocks, but no distance from the contact, and driving and cross-cutting appear to have been done largely in rocks of Devonian age, judging by the tips.

Its dimensions are 15 feet by 5 feet, whilst the depth is about 200 feet.

By sinking the shaft to the depth suggested, a considerable thickness of Ordovician rocks, with included bedded reefs, would be penetrated.

The western cross-cut would pass through a belt of hitherto unprospected (because not exposed on surface) country, whilst the drive south, in addition to connecting up for air and solving the unwatering question, would be the means of thoroughly testing the reefs over a considerable length.

The sinking of the Scandinavian shaft would probably be associated with rather heavy water troubles down to a limited depth, but this could no doubt be easily overcome by pumping. The bottom of the Patriarch shaft is about 150 feet above the Amalgamated tunnel workings, and this must be connected before the foregoing scheme is started.

In my opinion, scheme No. 2 offers far bigger possibilities than No. 1, and there would be a good prospect of payable reefs being cut in sinking the Scandinavian shaft, thus leading to early financial results.

Digitized by Google

SUMMARY.

Two schemes present themselves as being most likely to afford desirable information with regard to the prospects for the gold mines within the Hill End gold fields.

No. 1 is to test the Hawkins Hill reefs at a greater depth, and this can be done by either of the following methods:—

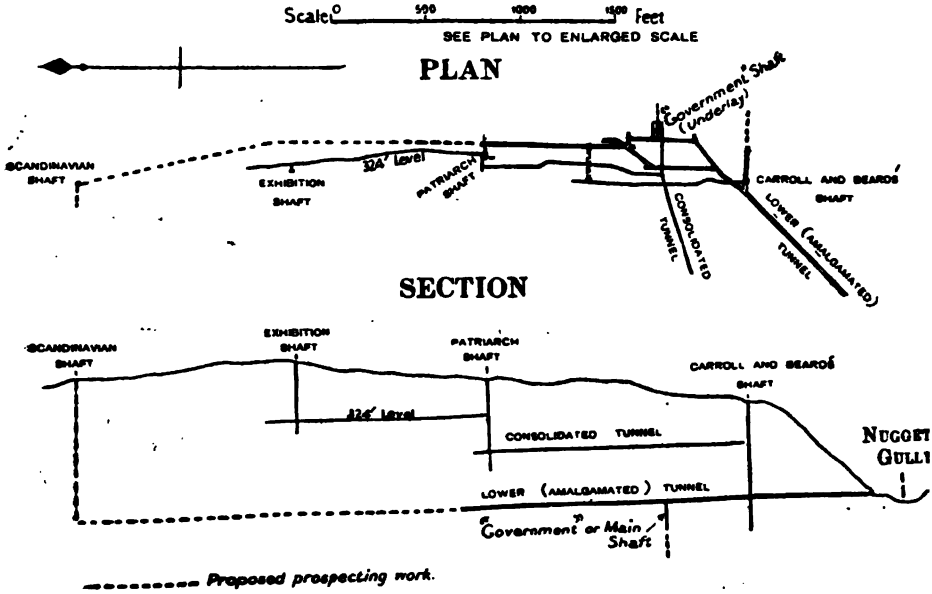
A. To deepen the shaft referred to as the Government shaft, and cross-cut east 50 feet and west 100 feet. Total cost, £1,275.

B. To unwater Carroll and Beard's shaft, and cross-cut east for 200 feet. Total cost, £800.

No. 2 to sink the Scandinavian shaft to a depth of 800 feet (present depth 200 feet), cross-cut west for 100 feet from the 800-feet level, and drive south to meet the Amalgamated tunnel, 2,000 feet (1,000 feet from each end).

A grant of £1,000 was approved in part furtherance of scheme No. 2, the same to be devoted to driving the Amalgamated tunnel 1,000 feet further north.

PLAN 2.



Digitized by Google

CHAPTER II.

PHYSIOGRAPHY.

The area dealt with in this report comprises portion of an extensive tableland with a general altitude of from 2,500 feet to 3,000 feet above sea level, and from 1,000 feet to 1,500 feet above the surrounding rivers.

This tableland is bounded on four sides by a river system, which all eventually finds its way by the courses of the Macquarie, Cudgegong, and Turon Rivers, and many creeks intersect the plateau, some of which are exceedingly steep over short distances, the fall amounting to 700 or 800 feet in less than half a mile.

In contrast to this it may be pointed out that the fall in the Macquarie River from the junction of the Turon to that of the Cudgegong, a distance of 54 miles along the course of the Macquarie, is slightly under 7½ feet per mile (aneroid levels only).

In a paper by the present writer entitled, "Notes on the Physiography and Geology of the North-eastern Watershed of the Macquarie River,"[1] the following opinions are expressed upon the physiography of this belt of country:—

> "It is considered that the Macquarie River is a *consequent stream*, resulting from the protracted uplift of the main Dividing Range."

The Hill End tableland area forms portion of the western peneplain which eventuated, and is practically isolated, as already pointed out.

To again quote from the paper referred to:—

> "Subsequent streams formed as the Macquarie deepened its channel, as represented by the Turon and Cudgegong Rivers."

The opinion is expressed that the uplift which gave rise to the Macquarie peneplain "commenced in the early Tertiary period, and was maintained throughout the greater part of that period, with occasional protracted stages of quiescence."

Two periods of lava flows are described, and referred to as Early Tertiary and Later Tertiary, and it is pointed out that after the rivers had "cut through the Later Tertiary basalt, and at least 600 feet into the underlying strata," the uplifting movement practically ceased at this stage, "and the rivers reaching the base level were no longer able to remove all the waste from the upland, with the result that the Macquarie River, below, even if not from above, the Turon junction, had to regrade itself on the accumulated beds of drift, thus becoming a *filled valley*, the present stream being at least 30 feet above the old valley bed."

The most prominent peak in the neighbourhood of Hill End is known as Bald Hill, with an altitude of 3,173 feet above sea level, and some 200 feet above the village.

The average annual rainfall at Hill End is about 28·93 inches, and during the summer, although the temperature is high at midday, cool nights are always experienced. In the winter months the climate is cold and bleak, with considerable rain and occasional falls of snow.

---

[1] Records Geol. Survey New South Wales, 1909. Vol. VIII., part IV., pp. 331-334.

Digitized by Google

With the exception of small areas of cultivated land adjacent to the creeks, the country is only suitable for grazing purposes, and sustains but a scanty population.

The timber is for the most part somewhat stunted, and consists of gum (*Eucalyptus viminalis*), white box (*E. albens*), red box (*E. polyanthemos*), and yellow box (*E. melliodora*), stringybark (*E. macrorrhyncha*), mountain apple (*E. elæophora*), &c., and it has been thought advisable in the interests of mining to conserve a considerable area of Crown lands in the Hill End district for firewood and mining timber.

GENERAL GEOLOGY.

Although only a comparatively small area is embraced in the accompanying geological map, the field examination covered a much more extensive area, and sufficient evidence was collected to enable an epitome to be given of the geology of a much larger belt of country in this locality.

The most striking feature of the rocks seen in the vicinity of Hill End are the number of occurrences due to volcanic agencies. For some miles south of the Turon River, through Hill End, to the neighbourhood of Tambaroora, for over 10 miles to both east and west of the former village, the rocks consist largely of volcanic tuffs and arkose rocks, with which are associated contemporaneous lava flows and comparatively narrow belts of slates. These surround a narrow exposure of highly-cleaved and crushed black slates with well-developed schistosity, mica schist, and crushed fine-grained sandstones.

Towards Tambaroora, and north from that village, the rocks assume more the nature of silicified mudstones and arenaceous claystones with occasional beds of more or less shaly dark-blue and grey slates. These continue for some miles north of Tambaroora (the Dirt Holes Creek), when tuffs and arkose rocks again become prominent and occupy much of the land surface to the north and east of Hargraves, 21 miles north of Hill End.

About 1 mile west and from 1½ mile to 2 miles east of Hill End, extending north and south for some miles, there occur belts of porphyry. These occurrences are in part in the form of sills, but they swell out in places and transgress the bedding planes, thus becoming normal intrusions.

In the north-west corner of the area mapped a large, irregular-shaped intrusion of a similar type of rock occurs, whilst some 8 miles south of Hill End, at Chambers' Creek, an extensive intrusion of granite occurs.

All these intrusions are of later age than both the Hill End series of sedimentary rocks, and have probably played a most important part in the formation of the auriferous veins and reefs.

A much more recent occurrence of volcanic rock is found capping Bald Hill, about one mile west of the village of Hill End. This consists of an area of basalt some 45 acres in extent, and all the evidence collected by the writer points to it being part of an early Tertiary lava flow or flows. Similar occurrences are to be seen capping Monkey Hill, off the main Bathurst-road, 11 miles easterly from Hill End, and Edge Hill or Tatuali Mountain, 10 miles north-north-west of Hill End.

Digitized by Google

Unfortunately palæontological evidence as to the age of the various formations in this belt of country has so far not been satisfactory. The central belt of sedimentary rocks in the vicinity of Hill End is undoubtedly much older than the surrounding rocks, but the writer failed to find any fossil remains therein. In view of the lithological character of these beds and their marked resemblance to the Bendigo (Victoria) series of Lower Silurian rocks (Ordovician), the writer is in favour of assigning that age to the Central Hill End belt.

There is no data available for determining whether anticlines and synclines occur in these beds, owing to the limited exposures, and with the exception of the most southerly outcrop which has a westerly dip, they all dip east mainly at from 60 to 70 degrees.

The rocks surrounding the exposures referred to in the foregoing paragraphs differ for the most part lithologically and structurally to a marked degree, but occasional belts of dark shaly slate and fine-grained tuffs, associated with the predominating coarsely-bedded tuffs and arkose rocks, render identification somewhat difficult. In many places these beds are found to contain crinoid stems, and occasional fragmentary coral remains, whilst one specimen of a brachispod of doubtful determination was found.

The actual definition of the age of this series is by no means certain, but field evidence and the lithological features of many of the beds appear to the writer to favour the Devonian age.

The possibility of both Devonian and Silurian sediments being represented received close attention, but no evidence to justify this differentiation was obtained.

These beds, which it is proposed to classify as of Devonian age, are folded into two anticlines, and they are as a rule dipping at lower angles than the earlier series.

A distinct unconformity between the two systems was identified at several points in Hill End Creek, just below the village, the most marked showing the younger to be dipping at an angle of about 43 degrees from the older. As a rule, however, the unconformity is not so marked, and the younger beds have been folded to such an extent that in places their dip almost coincides with that of the older rocks.

For the purpose of identification of each series throughout this work the writer will refer to them as Devonian and Ordovician, whilst admitting that no conclusive evidence was obtained.

The identification of contemporaneous lavas in the younger rocks is rendered very difficult in the field owing to the prevalence of volcanic tuffs and arkose sandstones. Hence a petrographical determination is absolutely essential, but owing to there not being any departmental lapidary at the time this work was prepared, only a very few sections were available for microscopic examination.

Mr. G. W. Card, A.R.S.M., Curator and Mineralogist to the Geological Survey, succeeded in getting a few sections prepared, however, and his examination leads him to consider that there are undoubtedly true igneous rocks present apart from the tuffs, arkose rocks, and intrusive masses.

Field evidence points strongly to these representing contemporaneous lava flows, but until all the rock specimens collected have been microscopically examined it is not possible to differentiate them.

Digitized by Google

TECTONICS.

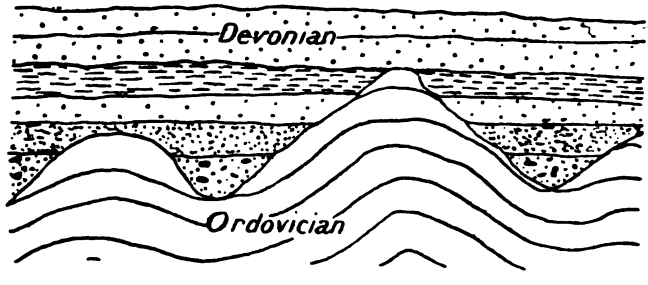
The tectonics of the Hill End-Tambaroora belt of country are not altogether easy of determination with any degree of definiteness and the subject is complicated by the absence of palæontological evidence as to the age of the beds represented.

The writer realises that the views set out here are liable to be questioned by readers who require chapter and verse for the opinions expressed, but they have been arrived at in the light of all the evidence available up to the present, much of which must be seen to be realised.

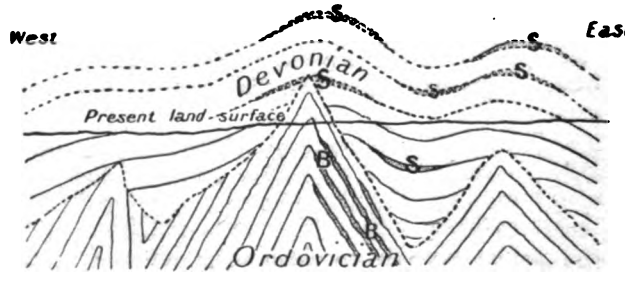
The earlier tectonic forces which have operated over this area will be dealt with first, but at the very outset the question of the geological age of the younger rocks raises difficulties.

Assuming that they are Devonian, then it would appear that during the early middle Palæozoic period of sedimentation, the region in question represented an unsubmerged area over which no strata was deposited. On the other hand should the younger series be of Silurian age, then there is no gap in sedimentation, but the Ordovician land surface was being slowly submerged and covered with sediments under conditions similar to those given below, but during the Silurian and not Devonian period.

Assuming the first supposition to be correct, it seems probable that within the area under consideration the Devonian sea rested on a floor of Ordovician rocks, probably already folded to some extent, with an elevated island or submarine mountain range projecting above the area of sedimentation. Thus:—



At a subsequent period (Pre-Carboniferous) the Devonian beds were folded, probably by epirogenic forces, and the folding in the Ordovician rocks was accentuated thus:—



S *Saddle reefs* B *Bedded reefs*

Digitized by Google

The northern and southern slopes of the Ordovician land surface appear to have influenced the pitch of the fold axes, whilst the strike of the Devonian axes may also have some relation to those in the Ordovician.

The orogenic forces appear to have operated so as to cause openings along the bedding planes of both ages of rock rather than true fissures, and although the openings may have originally been diminutive in width, the subsequent intrusion of mineral solutions under high pressure[1] would tend to enlarge some of the spaces between the bedding planes at the expense of others.

The whole of the foregoing probably occurred during a Pre-Carboniferous and Post-Devonian period, when many of the granite masses in New South Wales were intruded. It is thought that the sills of porphyry found to the east and west of Hill End, also the intrusive mass in the north-west corner of the accompanying geological map, represent the local equivalents of the granite masses, one of which is exposed about 8 miles south of Hill End, and covers a vast area in the Bathurst district.

As the plutonic masses stoped their way upward, they were accompanied by great volumes of mineral-charged vapours and hydrothermal solutions. These premeated the strained and fissured sedimentary rocks, and deposited their mineral contents in the open spaces, in addition to replacing adjacent country rock.

At a still later stage further earth movements developed, which caused faulting. This undoubtedly took place on two separate occasions (as described on p. 74, as shown in diagram), but these need not necessarily have been widely separated chronologically; in fact, the writer inclines to the belief that there was a prolonged period during which several tectonic forces were operating intermittently, such as faulting, vein filling, replacement, &c. All these would probably serve to enrich the gold contents of the primary veins, give rise to further replacement of the country rock, and form fresh veins. See "Two Periods of Veining Formation," p. 60.

The fault veins facilitated the percolation of vadose waters, thus leading to secondary enrichment, a feature most marked in the vicinity of the faults or cross courses.

Right here it may be advisable to call attention to the similarity of the vein materials (see p. 63) in both the older and younger rocks. This is most marked, and has an important bearing upon the age of the veins in the older rocks. As far as observed, the mineral constituents are the same in both cases, and moreover, one structural characteristic (*apparent* striation, see p. 60) is also found in the veins in both the older and younger rocks.

This leads to two possible deductions—

1. Either nature repeated herself during two widely separated geological periods, or
2. All the veins, reefs, and quartz blows are of Post-devonian age.

The first appears to the writer to be highly improbable, whilst No. 2 is much simpler, although somewhat startling, seeing that it entails assigning a comparatively recent geologic age to at least one belt of auriferous reefs in New South Wales, even though the containing rocks are referable to the Ordovician period.

[1] "Intrusive Pressure of Mineralising Solutions." Blayney Stevens, *Min. Mag.*, vol. XI, No. 5, 1914, p. 513.

Digitized by Google

If the younger rocks at Hill End prove to be Devonian, then a Post-Devonian age must be assigned to the reefs. A further point in support of this is the genetic origin of the reefs, which is attributed to the intrusion of the Bathurst granite, undoubtedly of Post-Devonian age, as it is found intruding beds containing typical Devonian fossils.

The opinion is held by many leading authorities[1] that auriferous veins are associated with the intrusion of igneous rocks. In this respect attention may again be called to the proximity of the extensive Bathurst bathylith.

The Bendigo saddle reefs, which occur in proved Ordovician rocks very similar lithologically to the beds containing the richest veins at Hill End, are considered by Dr. F. L. Stilwell, D.Sc.[2] to be probably of Devonian age.

If the present writer's deductions be correct, this would make them older than the bedded reefs of Hill End.

There is no evidence of either the Carboniferous, Permo-Carboniferous, or Mesozoic sediments having overlaid this area, although the land surface in places is higher than within areas some 30 miles to the eastward which are capped with Permo-Carboniferous and Mesozoic strata.

During the Tertiary period, the equivalents of the Macquarie River and its tributaries followed sinuous courses over part of this area, with the result that beds of river drift accumulated.

These are now found as isolated areas only, owing to denudation, and have been preserved by a covering of basalt, the result of Tertiary lava flows. Denudation has dissected the plateau, and exposed the Ordovician beds, but only over a very limited area.

---

[1] (1) Spurr, "Relation of Ore Deposition to Faulting." Ecm. Geol.; (2) Lindgren, "Mineral Deposits," p. 540; (3) Maclaren, "Gold," p. 76; &c.

[2] Bulletin No. 4. Advisory Council of Science and Industry "Gold Deposition in the Bendigo Gold Field," Melbourne, 1917, p. 23 and p. 61.

Digitized by Google

CHAPTER III.

DETAILED GEOLOGY.

A. Ordovician.

B. Devonian (?).

C. Post-Devonian Intrusions.

D. Tertiary Lava Flows.

ORDOVICIAN.

Chronological Differentiation.

A comparatively narrow belt of rocks found outcropping to the north and south of Hill End, and slightly to the west of the village (see accompanying geological map) have been assigned an *Ordovician* age purely on lithological grounds.

It is claimed that one specimen of graptolite was found by Dr. C. A. Mulholland during an examination of the field in 1912, but the specimen could not be traced, nor any confirmation of the statement obtained.

The writer and his assistant, Mr. E. J. Kenny, devoted considerable time to searching for indications of fossil remains in these rocks, but failed to find even a trace. This may be due in part to the fact that the black slates almost invariably break along cleavage fases and not beddding planes, thus rendering it difficult to expose imprints of fossils like graptolites.

Over much of the exposed portion of these beds, however, they have a most striking lithological resemblance to the Bendigo (Vic.) Ordovician beds, consisting as they do of dark-bluish slates, interbedded with somewhat lighter-coloured fine-grained sandstones.

In places at the northerly end of their exposed area the beds are so altered, and the primary constituents so replaced, that they have practically been converted into knotted schists.

Extent.

Reference to the geological map will afford the reader some idea as to the area of Ordovician rocks exposed, but some of this is so covered with soil and talus that the absolute contact line is only seen occasionally. Also the capping of younger rocks is so thin in places that shallow shafts or even drainage channels have penetrated the shell and exposed the older rocks.

In other places the Ordovician land surface was so precipitous that shafts in the younger rocks only a chain or two from the surface-line of contact have been sunk up to 400 feet before reaching the Ordovician rocks (Great Western Undaunted and others). Conversely, shafts sunk several hundred feet in the Ordovician have entered the Devonian strata after a few feet of cross-cutting (Exhibition shaft, &c.).

Unconformity and Lithological Differentiation.

There is undoubtedly an unconformity between these beds and the overlying rocks, but only in a few places was the junction sufficiently well exposed to enable specific data to be obtained.

Digitized by Google

In the western bank of the most easterly channel of Hill End Creek, a chain or two below Mr. L. Weir's hotel property, a narrow cut some 8 feet deep has been made by prospectors, and this passes right across the contact-plane between rocks of the two geological periods. Here the Ordovician rocks dip east at 88 degrees, whilst the overlying beds dip N. 75° E. at 45°, and the Ordovician land surface dips east at 56 degrees.

About 5 chains further south, in the bed of a small branch of Hill End Creek, the unconformity is well seen, and small isolated patches of the younger rocks also occur, filling depressions in the old land surface, whilst at the main line of contact the following dips were obtained: Ordovician, N. 70° E. at 85 degrees; Devonian, N 70° E. at 64 degrees.

It might be stated that, as far as the writer's interpretation of geological conditions in this neighbourhood are concerned, the key to the whole situation was first found in the narrow cut mentioned.

Geologists and others visiting the field are strongly urged to see this exposure before attempting to follow the deductions drawn.

The Ordovician beds in both cases mentioned consist of bleached clay-slates, much crushed and cleaved and somewhat decomposed, whilst the younger formation is a decomposed arkose rock or coarse tuff, exhibiting well-marked spheroidal weathering in places. Small fragmentary remains of an indeterminable fossil coral were found in this rock, but the rock itself is too weathered to permit of a microscopic determination.

One of the most characteristic features of the contact zone between the Ordovician and Devonian sediments at Hill End, and one that is far more serviceable than the unconformity, is the occurrence of a pronounced breccia formed of slate fragments embedded in a coarse tuffaceous or arkose rock.

This type of rock could only have been formed under two distinct circumstances. Either the slate fragments shelled off an already consolidated land surface into an area of more recent sedimentation, or the rock containing them must have been an intrusion.

The first explanation is undoubtedly the correct one, and there must have been a considerable geological gap between the laying down of each type of rock for the original mud to have consolidated into compact slate, which broke off in angular fragments.

The second hypothesis is negatived by the fact that the younger rock is decidedly clastic, and consists of beds of volcanic tuff or arkose rock, in places containing casts of encrinite stems and fragmentary coral remains.

This horizon is the more marked in that, whilst the Ordovician sediments are all finely-grained, the Devonian in most cases are coarse to medium-grained and tuffaceous, with most pronounced grains or crystals of felspar. So characteristic is this feature that the writer was largely influenced by it in determining the relative age of the rocks throughout the survey. It is most pronounced, and the deduction drawn was over and over again proved to be entirely supported by other evidence, such as fragmentary fossil remains (entirely absent in the older rocks), unconformity, dip, &c.

Underground the differentiation is rendered more difficult by the presence of miniature crystals of calcite in both ages of rock, which at first may be mistaken for felspar. These can be identified, however, by the readiness with which they may be scratched with a knife.

Digitized by Google

The breccia horizon can be seen in many places on the surface, right along the line of contact. Underground, in the Reward mine workings, it is strongly evidenced, and also in the most easterly cross-cut from the Consolidated tunnel. The latter example is particularly good, and afforded undoubted proof of the line of contact in a place where bedding planes are not so noticeable, and the unconformity might be missed owing to dust-covered rock faces and confusion of cleavage with bedding planes, for the former is identical in both ages of rock, within the contact zone, at all events.

Frequently this zone is marked by irregular makes of quartz, either in masses, bedded veins, or cross veins, the whole being associated with a more or less decomposed and shattered slate of Ordovician age. The "hanging wall" (formed by the Devonian rocks) usually marks the limitations of the infilling and replacement quartz, but occasional makes of quartz extend into or occur as isolated patches in the Devonian beds.

The writer is strongly of the opinion that this is the horizon occupied by the Frenchman's reef or blow, for wherever a reef was identified as the Frenchman's by old miners or those interested in the field, it was found to occur at the line of contact between the Devonian and Ordovician beds. Further particulars of this reef or "blow" are given on page 68.

Lest a mistake be made in the identity of the contact breccia, it should be pointed out that in places a pseudo-breccia occurs in both the older and younger sediments.

On closer examination, it will be seen that this formation in the Devonian rocks is not a true breccia, although consisting of "blebs" of slaty material embedded in a coarse, tuffaceous base. The finer-grained material is not in sharp angular fragments, but occurs as irregular blebs and short thin bands, both of which *merge* into the coarser material.

In the Ordovician beds, close to the junction of slates and fine-grained sandstones, a similar type of rock has been formed, but the sandstone matrix is always fine-grained, although occasionally given a coarser appearance by reason of the presence of innumerable small crystals of secondary calcite.

The origin of this type of rock is thought to be due to the temporary cessation of sedimentation, during which fine clay particles were concentrated in small depressions in the sea floor, but there was not enough material to form a distinct bed.

The sharp angular nature of the slate fragments in the true contact breccia is always most marked, thus rendering its identification comparatively easy.

Dip, Strike, and Cleavage.

Having regard to the age of these beds, it is rather unusual that foldings and severe crumplings should be marked by their absence. A few minor local crumplings were observed in the mine workings and along the outcrops, particularly on the south-west slopes of Hawkins Hill, but, on the whole, the dip and strike are very constant. The Star of Peace and the Mica veins (truly bedded) have now been followed down to a depth of over 700 feet from the surface, and, as far as mine surveys and local information indicate, the average dip has been very consistent throughout, the angle being from 60 to 70 degrees to the east.

Digitized by Google

The limited area of Ordovician rocks exposed may account for the marked consistency of dip, but even so it is contrary to the writer's experience in rocks of that age. It may be accounted for by the beds having been originally folded into a pronounced low anticline within the area exposed, which was accentuated, but not crumpled, during subsequent earth movements.

The most southerly exposure of Ordovician rocks is seen in a small prospecting cut on the left hand bank of Oakey Creek (see map), and there the dip is steeply to the west, with minor crumplings.

There must certainly be a series of anticlines and synclines over the exposed area, but, seeing that the only "leg" exposed has been proved to a depth of over 1,000 feet with no signs of folding, one of the anticlines must have been very persistent.

The strike is only a degree or two either way off the meridional throughout the area exposed, and even this deflection may be due to the "pull" exercised during the east and west faulting.

The cleavage is decidedly more noticeable than the bedding planes, and might very often be mistaken for them were it not for the presence of both thick and thin bands of fine-grained sandstone asssociated with slates, whereas the bedding is dipping to the east at from 60 to 70 degrees, the cleavage is almost vertical, or 10 degrees steeper than the dip in the same direction, and is far more pronounced in the slates than the sandstones.

As illustrating the cleavage and bedding planes, an excellent sample of country rock showing both, together with portion of the Mica vein, was collected for the Mining Museum. In this specimen the bedding dips east at an angle of 65 degrees, whilst the cleavage is at an angle of 75 degreees from the horizontal in the same direction.

Numerous jointings are found in the Ordovician rocks, in mine workings particularly, the most pronounced being steeply to the west. These are called droppers or indicators on the field, and they have in places had a marked influence on the gold contents of the reefs in their immediate neighbourhood, having in many cases led to great secondary enrichment.

DEVONIAN.

Chronological Differentiation.

Although the writer is disposed to consider most of the rocks occupying the area geologically surveyed as Devonian, it must be admitted that there is no tangible evidence in support. The opinion has been arrived at after taking into consideration a number of indefinite factors, which individually have no significance, but have evidently had a subconscious influence.

In the first case they can be traced with no apparent unconformity or lithological distinction into areas, in which Devonian fossils have been identified. The structure and lithological character of the beds over most of the area have much in common with those of proved Devonian age and differ from proved Silurian rocks in the surrounding districts.

The writer has not come in contact with any belt of Silurian sedimentation in the State so marked by the presence of massive beds of tuff and arkose rock, or the comparative absence of true slates.

Finally, the few fossil remains obtained, although useless to the palæontologist in arriving at a chronological determination, when viewed in the light of other evidence, appeal to the writer as having a slight significance.

Digitized by Google

Crinoid stems (casts mainly) are numerous, one or two specimens of a coral possibly referable to *Stromatopora*, a *Favosites*, and other indefinite coral remains occur, whilst one specimen of an imperfect brachiapod was found. The latter was not sufficiently well preserved to enable the Palæontologist (Mr. W. S. Dun) to identify, but it may be a Rhynconella.

On the other hand it should be pointed out that intercalated with the massive tuffs, &c., are narrow beds of a highly crushed and metamorphic character which severely shook the writer's opinions.

Thus it will be seen that after reviewing all the available evidence it amounts to practically nil, and in consequence the assigning of a Devonian age to these beds must be accepted as tentative only, and this age has been adopted in preference to Silurian on the writer's personal inclinations alone.

Whatever the age of these beds, they are apparently identical throughout the area mapped and extend for many miles over the surrounding country, with slight local variations only.

Lithological Characteristics.

The preponderance of tuffs and arkose rocks over a large part of the area examined is most pronounced. These range from a dense fine-grained dark-coloured, flinty rock, resembling a felsite, which probably represents a volcanic ash, to a coarse fragmental type, with many of the individual constituents readily distinguished with the nakes eye, and rarely containing pebbles.

The arkose rocks are all coarse in texture and frequently resemble a quartz-felspar porphyry, from which they were no doubt derived.

As a rule both these types are coarsely bedded (Hawkins' Hill), but exposures are to be seen (Bear Gully and Spring Creek particularly) where they are thinly bedded with bands of slate and silicified mudstones.

In places the tuffs and arkose rocks contain what at first sight would appear to be inclusions of partly-digested slate. These range from very small patches less than an inch in diameter up to blocks 8 feet long by 3 feet wide, but comparatively thin. Their origin appears to have been the deposition of clay sediment in depressions after the coarser material brought down by bood waters or deposited from showers of volcanic tuff, had been laid down.

The converse is also to be seen in places (particularly from 3 to 4 miles west of Hill End). Included in beds of shaly slate are narrow "bars" and lenticular patches (up to 2 feet by 4 inches) of rock, consisting of small rounded fragments of mudstone with angular fragments of quartz and felspar, with an occasional pebble of flinty rock, thickly scattered through a matrix of very fine-grained argillaceous and micaceous material.

Probably the felspar and quartz have been derived from weathering igneous rocks, and deposited in depressions of varying size and shape, not far from the source of origin, as evidenced by the angular nature of the fragments.

Digitized by Google

Both the foregoing at times give rise to a conglomeratic appearance, and may be in part the beds referred to as such by Mr. E. F. Pittman in his reports on the field. Exposures were seen, however, in which quartzite pebbles occur in the arkose rocks.

Numerous massive beds of sandstone, fine-grained, and exhibiting secondary silicification are found, notably up Sawpit Gully.

A peculiar feature of some of these beds is that they contain round accretions, frequently almost entirely separated from the surrounding rock. They are found to be highly calcareous and at times weather out from the rock as a rounded nodule the size of one's head. No trace of organic remains could be found in their centre, and it is somewhat difficult to account for their origin.

The Devonian beds in the immediate vicinity of Hill End, particularly near the post office, consist almost entirely of a crushed and decomposed rock, probably tuffaceous, exhibiting a pronounced spheroidal weathering, in which kernels of undecomposed rock are found. Fragmentary coral remains were found in this rock.

Going west from Hill End, for the first half mile the beds are very much altered and weathered. In fact so crushed and altered are they that in places it is impossible to identify them from the Ordovician, but they pass into what have been classfied as Devonian beds without any stratigraphical break.

Quartzites are plentiful, and for the most part these are fine-grained and dark in colour. In places they exhibit almost a schistose structure, particularly in the vicinity of the synclinal and anticlinal axis. In fact, as might be expected, almost all the Devonian rocks in the vicinity of the fold axes have been very much crushed and altered, either by decomposition or secondary mineralization.

Occasional beds of dark-coloured slate occur, which very much resemble the Ordovician slates. Marshall's line of reef, about 2 miles south-west of Hill End, and the eastern branch of Bear Gully, are two typical localities. After becoming familiar with the type, and seeing their mode of occurrency (they are decidedly lenticular), one forms the opinion that these slates have not the same silky lustre as the Ordovician, nor are they associated with bands of fine-grained sandstone. Moreover, encrinite stem casts are to be found in the associated coarser sediments.

As already stated, in the absence of microscopic determination, it is not possible to differentiate contemporaneous lava flows, but from the few specimens examined, Mr. G. W. Card, A.R.S.M., Mineralogist to the Geological Survey, is strongly of the opinion that such are present.

As Tambaroora is approached, the beds lose their arkose and tuffaceous character to a large extent, and are more of the nature of silicified mudstones with occasional beds of volcanic tuff, as a rule finer in grain than the Hill End series.

It may be pointed out that secondary silicification is very pronounced in many of the rocks in this area, a feature rather characteristic of Devonian

Digitized by Google

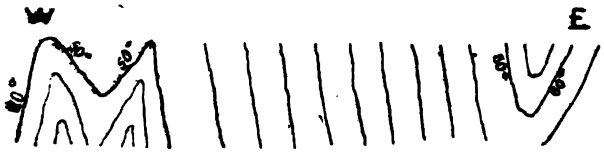
sediments in this State, and that for beds of that age they have been very highly crushed and altered in places, but this may be due to the enormous dynamic stresses to which this belt has been subjected.

In concluding the petrographical description it may be advisable to again call attention to the presence of coarse felspar grains in most of the Devonian rocks, and to emphasise the importance of this characteristic in differentiating the two formations in the field.

Dip and Strike.

As is to be expected in a region where the beds have been folded into a series of anticlines and synclines, the angle of dip varies very much. The folding has been more or less gentle, so that flat dips are to be obtained in the neighbourhood of the fold axes. West from the most westerly anticline the beds dip steeply to the west, in some cases at an angle of over 80°. Owing to the impossibility of comparing dips on any one particular horizon right across the folded area, exact figures cannot be given, but as a rule the dip is not so steep on either side of the western syncline, and probably does not exceed 50° at the steepest point. The dip on the beds forming the eastern leg of the eastern anticline reaches 80° in places, and again flattens somewhat as they rise on the opposite side of the syncline to about 60°.

A section across the fold axis on any one geological horizon would be approximately as under:—



The direction of dip is far more constant and is seldom more than a few degrees either way from the east or west. The exception is found in the neighbourhood of the main fault (Tambaroora), where, owing to the "pull" of the fault, the dip swings round north-west and south-east on the northern side of the fault, but a little further north again assumes its normal directions. On the whole it may be said that an average meridional strike exists, with possibly a very slight tendency to swing a little to the west of north.

Folding.

The Devonian beds within the area geologically surveyed have been folded into two anticlines and two synclines, each of which is referred to as eastern or western, according to its relative position.

They persist throughout the length of country mapped, and when once identified are not hard to follow, the more so when it is realised that most of the contained quartz reefs in the country folded are truly bedded, thus affording the desired evidence when dips in the containing rocks are not available.

Digitized by Google

The best localities for identifying each of these folds are respectively as follows:—

Western Anticline.

In the bed of Sawpit Gully, about 7 chains above its junction with Oakey Creek.

In the bed of Oakey Creek, some 10 chains below the Nuggetty Gully Junction.

On the road to the Recreation Reserve, passing over the southern end of Sargent's Hill.

In the bed of Tambaroora Creek, about half a mile below the Hargraves-road crossing.

Western Syncline.

In the bed of Hill End Creek, above and below Mr. Weir's hotel.

In the bed of Tambaroora Creek, just below the Hargraves-road crossing.

Eastern Anticline.

In the bed of Oakey Creek, about half a mile above its junction with the Turon River.

In a gully to the west of Long Flat, as you descend Hawkins Hill.

Just behind the Hill End Post Office.

On the eastern side of the Hargraves-road, shortly after crossing Tambaroora Creek.

Eastern Syncline.

This fold is masked by the intrusion of a sill of porphyry along its axis, but the dips on either side of the intrusion clearly prove a synclinal fold.

These dips can be seen on the Hill End-Sofala road, about 3 miles from Hill End, and in the bed of the Turon River above Deep Creek.

In fact all the above folds are to be identified in the Turon River gorge.

The section, given on p. 29, affords general particulars as to the folding, but this varies somewhat in a cross section taken in different places, and moreover the good exposures are not directly opposite one another right across the folded belt, so the section given must be considered as more or less of a compromise.

As far as the available evidence indicates, the fold axes have a slight pitch to the south at the southern end of the field, and to the north at the northern end, with an apex in the neighbourhood of Sargent's Hill, but definite data could not be obtained.

The western anticlinal axis swings slightly to the west towards the centre of the field, but comes back to its original north and south bearing in the neighbourhood of Tambaroora. The remaining axes have a more or less meridional strike; that of the eastern syncline, however, is entirely masked by the intrusive porphyry.

Reference to the geological map will enable readers to follow the foregoing particulars, and get an idea of the relative position of the axes.

The Devonian beds exhibit well-marked jointing in places, but no consistency in the angle of dip or strike in the joints was noted. The most pronounced jointing, as observed in Tambaroora Creek, was N. 52° E. at 51°, and S. 10° E. at 54°. In the bed of Hill End Creek, below Chappel's dam, the jointing is very marked. It is more or less rectangular, and gives rock faces the appearance of a stack of bricks.

Digitized by Google

POST-DEVONIAN (?) INTRUSIONS.

Four occurrences of this type were found within the area embraced by the accompanying geological map. One belt occurs approximately one and a quarter miles west of Hill End, and extends from about three-quarters of a mile south-west of Bald Hill to the northern confines of the map, but its actual northerly termination was not reached. The average width of this belt is about 15 chains, but it widens as traced north. Excellent natural sections are to be seen in Washing Gully and Tambaroora Creek, and in the latter exposure the nature of the occurrance can be studied to the best advantage, for the actual line of contact is to be seen in the rocky bed of the creek.

Large masses of undigested sedimentary rocks occur embedded in the igneous mass, and the somewhat irregular junction line between the overlying sediments and the intrusion is exposed. The former have been very much indurated and silicified, and whilst their general dip a few chains from the contact is westerly at about 55°, close to the igneous mass it is either vertical or N. 70° E. at 88°.

Occasional nests of silvery mica occur in both formations near their contact, and the porphyry, in addition to the porphyritic quartz crystals, contains large blebs and veins of quartz.

The rock weathers similar to granite, and large rounded blocks, extensive flat surfaces of bare rock, or concentrically weathering boulders with hard kernels, are common. A feature of the rock in the field or in hand specimens is the large porphyritic crystals of quartz, which frequently have a distinctly amethystine tint.

There is no reason to doubt that this occurrence is in the nature of a sill, for it conforms very closely to the bedding planes of the adjoining sediments throughout its length, the only exception being when it widens out and breaks across to adjoining planes. The large included masses of partly digested sediments also point favourably to this mode of occurrence.

Another occurrence is found about 2 miles east of Hill End, extending from north to south throughout the area mapped, but, as will be seen on reference to the map, its northern termination was not reached.

It is seen crossing the Bathurst-road, about 3 miles from Hill End, where it has an exposed width of 15 chains. The intrustion thickens very much as followed north, and also towards the south up to a certain point, when it bifurcates.

The most easterly split extends south for only a few chains, but the westerly portion can be traced down to the Turon River, about 12 chains south of which it dies out. Towards the southern end, before reaching the river, it is characterised by very bold, massive outcrops, and near the river a well-marked pseudo-bedding conforming with that of the adjoining sediments is noticeable.

Many inclusions of undigested sedimentary rocks occur, and towards the sides the rock becomes much finer grained. The porphyritic crystals in this intrustion consist for the most part of felspar, many of which measure over a quarter of an inch on their longest axis.

Digitized by Google

In many places these crystals are embedded in a dark-greenish matrix, which resembles serpentinous material. The rock has apparently been subjected to considerable crushing, for in places quite a gneissic structure is observed.

About 5 chains east of where Deep Creek junctions with the Turon River, or about 2½ miles south-east of Hill End, another occurrence is to be seen. This also strikes north and south, is about 5 chains wide, and extends south beyond the confines of the map, whilst its northerly termination is to be seen about 1 mile south of the Bathurst-road.

There is no doubt that these intrusions are later than the beds to which a Devonian age has been assigned, and the probability that they were injected subsequent to folding is evidenced by the most easterly occurrence being situated along the axis of a syncline, for here the sediments on the west side dip east, and on the easterly side have a westerly dip in both cases at an angle of from 60 to 80 degrees.

The fold axis would be a line of weakness, and other factors being favourable, the porphyry might be expected to force its way through a severely strained zone.

Yet another occurrence of porphyry was located in the north-west corner of the area mapped. In this case the outcrop is more in the nature of an intrusive boss, but the rock is similar to the western belt of porphyry already described.

TERTIARY LAVA FLOWS.

Although only one exposure of this nature is included in the accompanying geological map, the writer is of the opinion that it represents a portion of the Early Tertiary Flows, remains of which are found capping many of the higher points within the area examined.

The opinion was expressed by Mr. J. A. Watt,[1] at that time Geological Surveyor, that the Hill End Bald Hill exposure of basalt represents "the molten material that filled the pipe or neck of a basaltic volcano."

The reasons given for this opinion are that several shafts round the edge of Bald Hill have basalt on the hanging-wall side, and slate on the footwall, and "the slates are somewhat disturbed at the junction;" also, that in a tunnel then being driven under the hill from the east side "a small dyke of very decomposed vesicular basalt" was met with 170 feet in from the mouth.

The shafts referred to have since fallen in, but after a careful examination of all the outcrops of sedimentary rocks surrounding the hill, the writer failed to find any disturbance in the dips, all being steeply to the west. Had a lava flow ended up against a steep bank, the occurrence of basalt and sedimentary rocks, as observed in the shafts, might be expected.

No dyke material was identified in the tunnel referred to by Mr. Watt, and it has since been extended for 800 feet under the hill, and only sedimentary rocks were met with, all dipping steeply to the west.

[1] Annual Report Dept. of Mines, 1898, p. 176.

Digitized by Google

In view of the foregoing, and after an examination of all the "bald hills" on either side of the Macquarie River, the writer is convinced that the Hill End Bald Hill is formed by a capping of a once extensive Early Tertiary lava flow.

Exposures indicate that there is an absence of Tertiary drift under the flow in this locality, which may be accounted for by the lava having spread over a flat surface devoid of drift.

The remaining thickness of basalt is about 150 feet, and the area approximately 45 acres. The rock consists of a typical olivine basalt, and Mr. Pittman has recorded the presence in places of chabasite and corundum.

There is clearly no association of this exposure with the auriferous lodes of Hill End, and chronologically it is very much younger.

Digitized by Google

CHAPTER IV.

EARLY HISTORY

OF

THE VARIOUS CLAIMS

AND

RECENT MINING OPERATIONS,

With Suggestions as to Future Prospecting Work.

So many years have elapsed since the majority of the quartz veins or reefs on the Hill End-Tambaroora Gold-field have been worked that it is now difficult to obtain reliable information concerning them.

Moreover, the field has been so riddled with prospecting shafts tunnels that the history of all the "claims," even if available, would f fair-sized volume.

The map published in 1873, and reproduced in this volume, will show the claims held at the southern and central portion of the field at time, but many have been taken up over and over again, and diffe prospecting work carried out.

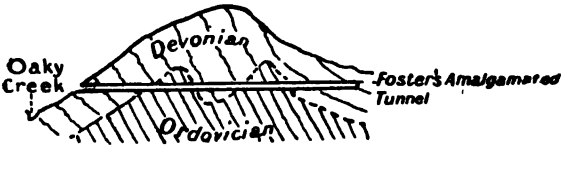
The following information has been gleaned regarding some of principal claims, and although far from complete, and possibly only m or less accurate, it may prove of some interest.

The various workings about which anything is known will be dealt w from south to north, commencing on the north side of the Turon River.

The South Star mine is situated on the top of the ridge between Turon River and Oakey Creek, and is undoubtedly in the younger roc A shaft has been sunk to a depth of 200 feet, and much of the reef sto out for a length of 700 or 800 feet along the line of strike down to a de of 100 feet. It is reported to have been worked from the early sixties horse-power battery being used, but nothing has been done for the p fifteen years.

The most important mining work of the past ascending Oakey is kno as Foster's Amalgamated Tunnel. This tunnel is situated on the left-h bank of Oakey Creek, some 10 chains below the junction of Nuggetty G It is about 120 feet below the Hill End Amalgamated Tunnel, and driven during the years 1872-75. The distance to the face is about 1,200 in a direction bearing approximately N. 65° E.

The tunnel appears to have been started in Devonian rocks, but pa through two belts of Ordovician strata thus:—



Digitized by Google

Sc
on t
diffi
M
tun
fair
T
the
tim
pros
T
prin
or l
T
fro
T
Tur
A s
out
of 1
hor
fifte
T
as l
ban
It i
driv
in a
T
thro

Digitized by Google

Three veins were cut and identified at the time as corresponding to Lady Belmore, Brand and Fletcher's, and Amalgamated of Hawkins Hill proper.

Only the Amalgamated vein paid to work, and this was driven on south for 200 feet, and stoped up for about 80 feet. A level was also driven north, and connected by a winze to a tunnel about 50 feet overhead, in which a similar occurrence as regards beds penetrated was proved. Returns do not appear to have been encouraging, and work was abandoned.

The position of the tunnel, as regards the Ordovician strata, was unfortunate, for it only penetrated two isolated peaks of those rocks, and apparently had no chance of reaching the main Hawkins' Hill veins, should they persist, owing to the contour of the old land surface leaving them well below the tunnel level.

Hawkins Hill Veins.

The principal veins on Hawkins Hill, as identified durnig the "seventies," are as follow, extending from Nuggetty Gully on the west to beyond the crest of the hill on the east:—Prince Alfred, Lady Belmore, Brand and Fletcher's or Amalgamated, Phillipson's, West Workings (Mica Vein or Beyers and Holterman's), Star of Peace, Middle Workings, Paxton's, East Vein, Moustaka's, Herman's, Frenchman's, Daddy's Reef, Rowley's Reef (probably identical), Mountain Maid Reef.

Of these all but the Prince Alfred and the last four are true-bedded veins in Ordovician rocks, and often consisted of more than a single vein, the name being applied in many cases to a group of veins, which were individualised by their relation to the walls, *i.e.*, hanging wall, middle, or footwall vein.

The Frenchman's is thought to be in the nature of a contact reef or "blow," and occurs at the junction of the two geological periods represented.

Prince Alfred's, Daddy's, Rowley's, and the Mountain Maid reefs are all inverted saddle reefs, or easterly dipping legs, in rocks of assumed Devonian age.

The total width of the belt of country carrying these veins is under 10 chains, and it is safe to say that in many cases they have been followed almost continuously for a length of about 1,200 feet along the pitch of the ore chute.

The number of individual claims on Hawkins Hill during the early "seventies" appears to have been in the neighbourhood of 120, and this over a length of only about two miles along the line of strike of the veins. The length of some of the claims did not exceed 50 feet, and one or two were probably nearer 20 feet. In fact very few of the claims held much more than 100 feet along the strike, and owing to the steepness of the hillside it was often necessary to erect stone walls on the lower side of the claims in order to prevent the mullock from encroaching upon an adjoining claim lower down the hill.

Towards the close of 1872 a "company" boom appears to have started in regard to the various claims on Hawkins Hill, and whilst a few of them proved "gilt-edged" speculations for the shareholders, the majority of the companies floated were so hampered on account of the financial conditions

Digitized by Google

imposed by the vendors that practically no funds were available for development work, and the "claims" were never thoroughly prospected. Even if a rich make of stone was proved and worked, the money thus obtained was distributed in dividends, although no development work was done ahead to locate a further make of pay ore.

It is fairly safe to say that this principle, coupled with an inadequate knowledge of the factors governing the chutes of ore, and the small area held by individual companies was more the cause of a slump in mining operations than the temporary decrease in gold values. The word temporary is used advisedly, for the writer is of the opinion that the future prospects of this field are decidedly encouraging, an opinion already justified by developments subsequent to the present geological survey.

The following detailed information was gathered in respect to some of the claims, but it is far from complete, and dependent in part upon the memory of men who worked the ground. General information with regard to individual lines of reef is given in Table A (p. 42), but many of the yields are an approximation only.

The Star of Peace Mine.

This claim was first worked about the year 1870, and although several of the recognised Hawkins Hill series of veins were opened up, the principal work was done on the Star of Peace veins; but in the upper levels, rich makes of ore were worked in the Middle and West workings (Mica vein) series.

The claim had a frontage of 153 feet on the line of reefs and extended east and west for a considerable distance. Two shafts were sunk, the main shaft being perpendicular for 200 feet, after which it followed the underlay of the vein for 521 feet. A winze was sunk 114 feet south of the shaft from the bottom stopes at the 765-feet level, for 56 feet, making the deepest workings 821 feet from the surface.

From the 150-feet to the 500-feet level the vein was entirely stoped out for the length of the claim, the best returns being obtained north of the shaft. From the 500 to the 700 feet level the shaft was sunk on the vein, but apparently no stoping was done. Below the 700-feet level the vein was stoped for about 140 feet south, down to the bottom of the workings, and in places proved very rich.

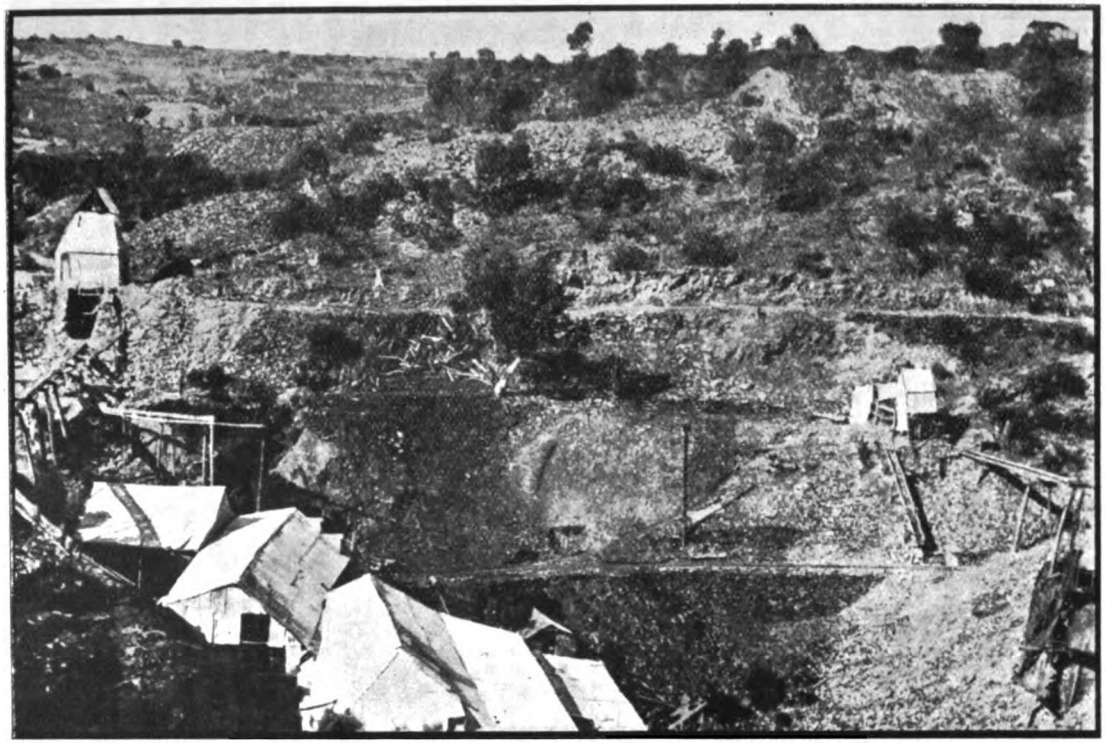
A cross-cut west for 40 feet from the 750-feet level cut fourteen veins, varying from 2 to 4 inches in thickness; whereas a cross-cut west for 60 feet in the upper levels of the adjoining claim exposed only three veins. This proves that numerous additional veins are making in depth, and is again referred to on p. 54.

The return from this claim up to 31st December, 1879, as compiled by the then manager, "equalled 17,808·78 oz. of gold, which realised £68,862 0s. 2d. Dividends paid amounted to £13,690 12s. 6d."

In 1880 the claim was incorporated in an amalgamation company scheme, apparently with disastrous results to the shareholders.

Digitized by Google

PLATE VI.



The Star of Peace Battery, 1883. Northern end of Hawkins Hill.

Digitized by Google

Digitized by Google

Keohmann's Claim.

This claim appears to have been first worked in 1870, and embraced several of the Hawkins' Hill veins, which, however, were all expected to pass into the adjoining claim to the east at a depth of from 400 to 700 feet.

The deepest shaft was down about 400 feet vertical, and several of the veins appear to have been stoped out from 250-feet to 300-feet levels for the length of the claim (128 feet).

In April, 1872, this claim was floated into a company, with a capital of £80,000 in 80,000 shares of £1 each, most of the capital being absorbed by the vendors.

The amount of gold won by this company to 31st December, 1878, was 48,189 oz., valued at £183,760 2s. 2d., of which £157,000 was paid in dividends.

Beyers and Holterman's Claim.

The claim held by this party, from which the mass of gold referred to on p. 14 was obtained towards the close of 1871, had a length of 125 feet 6 inches along the line of reefs. It was floated into a company on 17th April, 1872, with a capital of £72,000 in 72,000 shares of £1 each.

Up to 31st December, 1878, the company won 26,403 oz. 15 dwt. of gold, valued at £106,407 15s. 9d., from which dividends amounting to £1 1s. 7d. per share were paid, the vendors receiving most of the original capital in hard cash.

The workings on this property reached a depth of about 400 feet, and most of the stoping was done on the Mica vein, which was taken out from about 50 feet to 300 feet for the full length of the claim (125 feet 6 inches).

Carroll and Beard's Claim.

Carroll and Beard's claim was first worked in 1870, and good returns obtained up to 1872, when it was floated into a company on the 2nd May, with a capital of £90,000 in 90,000 shares of £1 each. Very little of this was available for development work, but good returns were obtained almost from the first. The amount of gold won by this company up to 31st December, 1878, was 15,035 oz. 2 dwt., which realised £57,008 17s. 3d., dividends amounting to £36,000 being paid (8s. per share on 90,000 shares).

An amalgamation scheme between the three foregoing companies was arranged in February, 1879, and the main shaft sunk to its present level in 1881, the stoping and cross-cutting being carried on until 1884. Here again the death-knell appears to have been sounded of the claims so enormously rich in the early days.

Paxton's.

This claim was first worked in February, 1867, the lease having a frontage of 124 feet 6 inches on the line of veins, with a width of about 300 yards. Two shafts were sunk, the north shaft being 170 feet vertical and 400 feet on the underlay of the Star of Peace vein, which was stoped down to the 260-feet level for the full length of the claim. Below this, down to the 320-feet level, it was only stoped out to 40 feet south of the north shaft, and up to the Star of Peace boundary on the north.

Digitized by Google

Paxton's vein was cut in the vertical shaft at the 130-feet level, and stoped to a depth of 260 feet for the full length of the claim to within 70 feet of the surface. This vein was sunk on to the 390-feet level, and the westerly veins stoped to the 260-feet level.

The easterly veins were stoped to 300 feet, and tributors were still obtaining gold returns at the time Mr. J. W. Marshall, mining manager, submitted the report from which the foregoing information was obtained (21st April, 1880). The south shaft was vertical for 138 feet, and continued on the underlay of Paxton's vein, which was stoped out to the 320-feet level, the best gold having been won between the 130 and 260 feet levels.

From the half-yearly reports to 31st December, 1879, it would appear that 9,112 oz. of gold, realising £35,224 5s. 10d., had been produced from about 1872.

That this is only a small proportion of the gold won since the claim was first taken up is evidenced from the following extracts from an article in the *Sydney Morning Herald* of 10th January, 1880.

One of the shafts was sunk to 120 feet, and no return had been obtained for eighteen months' work. The two shafts were connected at the 100-feet level for ventilation purposes, and quite by accident a rich piece of quartz was found, leading to the first make of pay ore, which yielded, on crushing, 800 oz. of gold per ton.

The vein was very narrow, but each shift was able to get out half a bucketful of stone, that is, about 5 cwt. per week—something like a weekly income of £800 to be divided between four men.

At a later date the Star of Peace vein was cut, and stoped out for the full length of the claim down to 260 feet. There were three veins in this line, known as Hanging, Middle, and Footwall vein, varying from 6 to 30 inches wide.

Two tons of ore from the Middle vein yielded 4,250 oz. of gold, whilst eighteen weeks' work resulted in £40,460 worth of gold being recovered. During the year 1870, £160,000 worth of gold appears to have been won.

To sum up the available evidence, this claim, with a length of only 124 feet 6 inches, produced over £200,000 worth of gold, two-thirds of which was won during less than one year.

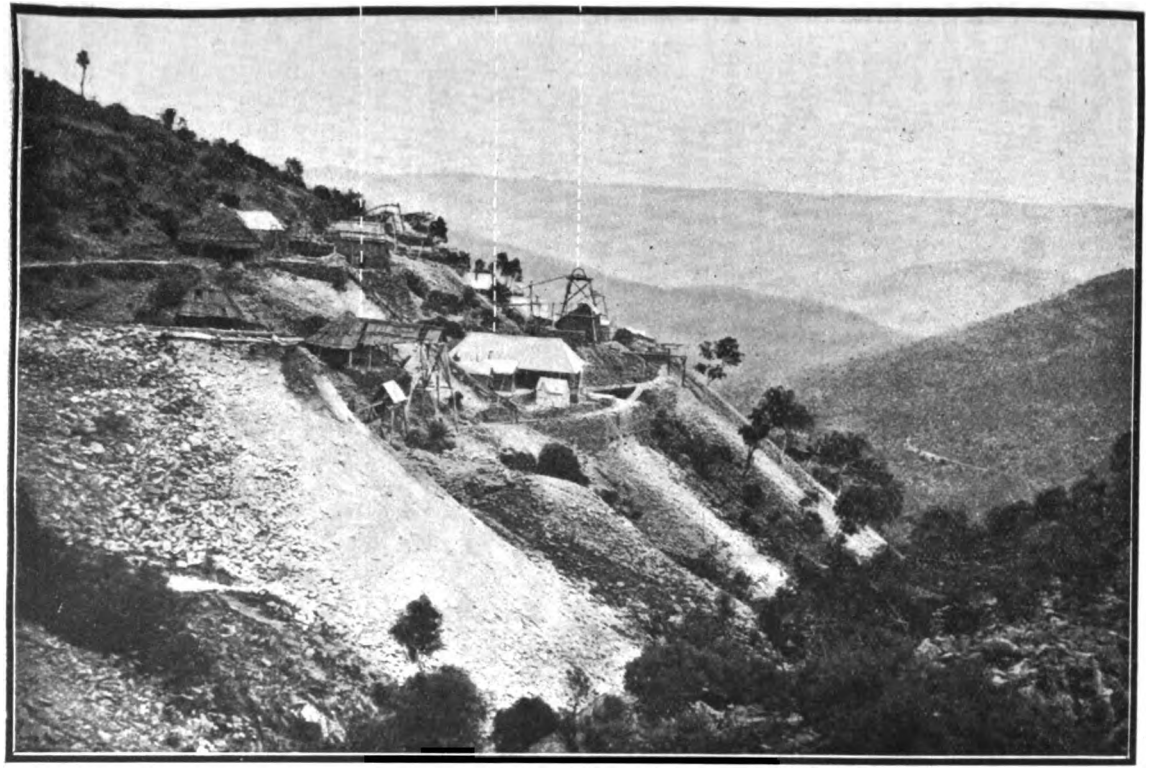
Here again we find that, whilst the first claim-holders (four men) won a large fortune, and the succeeding company did well, the shareholders in an amalgamated company all lost their money, not because the mine was worked out, but due to a lack of foresight in not providing capital for sinking through the poor zone. This is borne out by the fact that less than 200 feet below the old shaft the Mica vein alone has been proved to yield up to 1,000 oz. per ton in places.

Herman's.

This lease embraced 86 feet along the strike of the veins, with a width of 300 feet, and after the original holder had obtained good yields for a year or two a company was formed during 1872, with a capital of £50,000.

The deepest workings appear to have been a vertical shaft 400 feet, with a continuation by underlay shaft on the Star of Peace vein for 100 feet.

Digitized by Google



Part of Hawkins Hill, looking south, 1880.

Digitized by Google

Digitized by Google

Both Paxton's and the Star of Peace veins were worked, the former being more in the nature of a "blow" in the vicinity of a cross course or fault.

After the formation of the company £12,605 12s. 2d. worth of gold was recovered, and even when it was worked on tribute at a later date, 2,432 oz. of gold were obtained from 360 tons of ore.

Fischer and Beard's.

This claim was 136 feet long on the strike of the veins, the two most important of which were Paxton's and the Star of Peace.

No authentic information regarding the earliest history of the claim is available, but in 1873 it was taken over by a company, with practically no working capital, the purchase having absorbed most of the £60,000 obtained from 60,000 shares of £1 each.

The main shaft was perpendicular to a depth of 380 feet, and a cross-cut was driven west for 60 feet from the 310-feet level.

The company obtained £41,000 worth of gold up to 1879, won from Paxton's and the Star of Peace veins.

Crushings made between August, 1874, and April, 1880, totalled 3,327 tons, for a yield of 9,023 oz. 8 dwt. of gold.

The Goldenville.

This was the name of a small claim, 16 perches in area, which was floated into a company with a nominal capital of £12,000. Most of this was paid to the vendor, and the small sum left for working expenses was soon expended, but no values proved.

Brown's, or Northumberland.

This was a claim covering most of the Hawkins Hill series of veins over a length of 42 feet only.

Mr. Brown, known as "Northumberland Jimmy," commenced work in 1866, but it was not until July, 1869, that the rich makes of stone were struck.

The Star of Peace vein was worked to a depth of 210 feet when values gave out, but it is estimated that over £30,000 worth of gold was obtained from this small claim, five separate veins being stoped from the grass roots to 200 feet.

Porter and Rawsthorn's.

No detailed information is available regarding this claim, which was only 68 feet long, but about £40,000 worth of gold appears to have been won prior to its formation into a company with a capital of £120,000. Subsequent yields and work done could not be ascertained, but apparently results did not justify the flotation.

The Monte Christo.

This was a company formed during 1871, to purchase a half interest in the claim known as the A1 or Messrs. Hurley and Moore's. The claim was 69 feet long on the base line of the reefs, and had a width of 600 feet. The capital was £15,000, in 600 shares at £25 each, paid up, 200 shares to be reserved by the proprietor in addition to a cash consideration.

Digitized by Google

Messrs. Hurley and Moore had worked the "flat ground" (see page 70), containing five veins, into a depth of about 200 feet, with cross-cuts east and west, and levels on the veins worked, which were very rich here, and from which excellent results were obtained.

At the time the company took over, there was a quantity of ore at grass, of which 12 tons were expected to yield 50 oz. of gold per ton, and 40 or 50 tons to average 10 oz.

Rose of England.

This appears to have been one of the earliest claims worked, and prior to 1872, when it was floated into a company, £28,000 worth of gold is reputed to have been won. Work done was entirely on the "flat ground."

The following information as to yields was obtained from the *Sydney Morning Herald* of 1872 (exact date not known). One ton of picked quartz yielded 812 oz. of gold; 9 or 10 tons of "seconds" yielded 530 oz. of gold, or a total of 1,362 oz. for eight or nine days' labour.

The Patriarch.

This claim was formerly known as the Trust and Try, the ground held comprising 1 acre 3 roods 32 perches, but no information is available with regard to gold won. The reefs worked appear to have been Frenchman's, Paxton's, Star of Peace, and a new vein called the Calcite reef.

The claim was taken over by a company in the early seventies, with a nominal capital of £24,000. At that time the two shafts were sunk to a depth of 160 and 90 feet respectively, and it was expected to strike the Frenchman's reef in about another 40 feet.

The proprietors disposed of a half share for £12,000, "£2,000 of which will be applied for the working of the mine."

The main shaft was sunk to 360 feet, and a crushing of 18 tons from the Frenchman's vein at that level in February, 1878, gave a return of 49 oz. of gold. Funds gave out shortly after 1880, and work was abandoned.

The main shaft was subsequently sunk to a depth of 500 feet, by an English company under Colonel North, who had taken up a considerable area of ground on Hawkins Hill during 1884.

This company appears to have been wound up shortly afterwards, however, practically no crushings having been made.

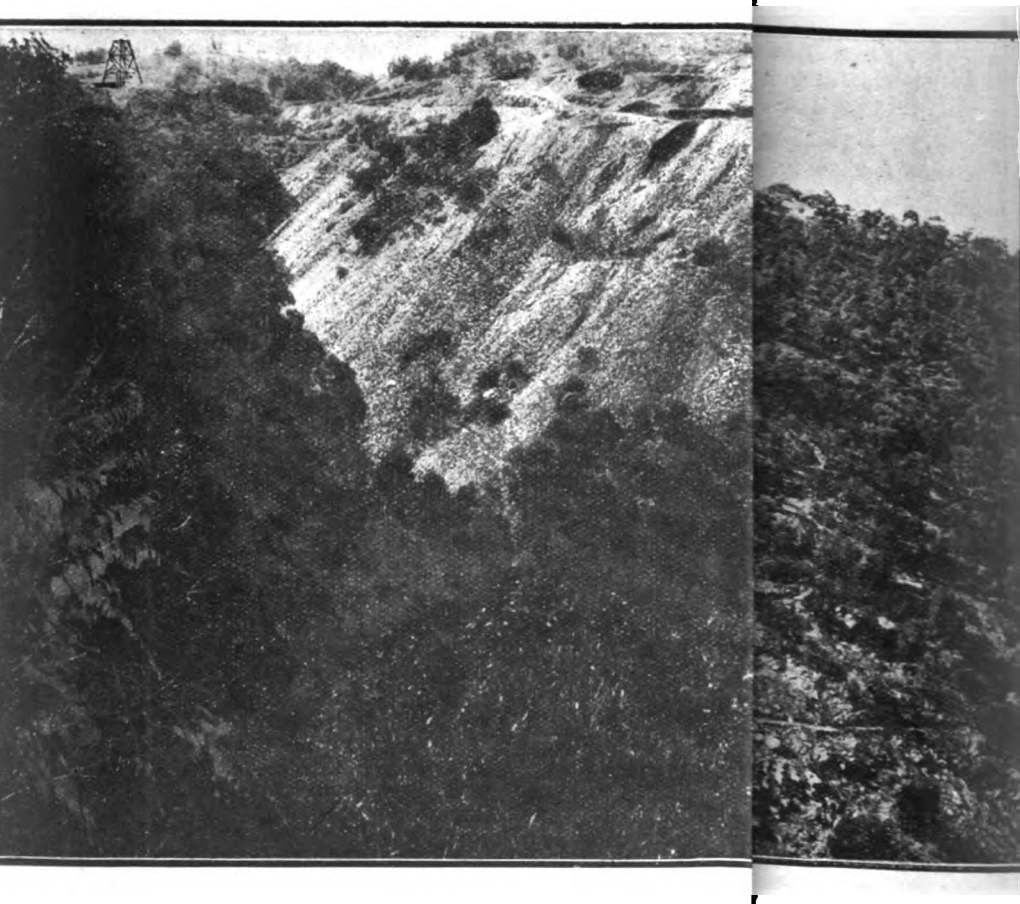
The ground is now held by the Hawkins' Hill Central Gold-mining Company, excellent poppet legs having been erected over the shaft some two years ago, and it is now being holed through to the Amalgamated tunnel workings with a view to making it the main working shaft for the whole of the ground held by the Marshall's Hill End Amalgamated Company, Hawkins Hill Central, and Hawkins Hill Deep Levels Company, all three of which are dealt with on pages 47 to 56.

Three claims appear to have been worked immediately north of the Patriarch ground, namely, the Cornish, Frenchman's, and Cornelian, the greatest depth reached being 300 feet, and three reefs stoped out over a length of 800 feet down to a depth of 300 feet.

Digitized by Google

Digitized by Google

PLATE VIII.



The poppet legs on the extreme left are over the Hawkins Hill Central Consolidated Tunnel

Digitized by Google

The following table was published[1] in a booklet issued by the Star of Peace Gold Mining Company during 1880:—

Name of Lease or Company.	Nominal Capital.	Width of Ground on Course of Veins.	Elevation of Shaft or Tunnel Mouth above Summer Level of Turon.	Reported Value of Results obtained before February, 1872.
	£	ft. in.		
Johnson's	15,000	164 0	S. 1164·44	No crushings on gold.
Holston & Co. / King & Everett's — Now Grinding Star Amalgamated.	65,000	98 6 104 6	T.M. 951·21 T.M. 876·11	" " " " " "
Beppo	125,000	72 0	S. 1159·96 T.M. 1061·70	" " "
Carroll & Beard's	90,000	98 0	S. 1215·30	Rich stone.
Krohmann's	80,000	128 0	S. 1219·80 S. 1221·90	About £30,000.
Beyers & Holterman's	72,000	125 6	S. 1246·48 S. 1235·18	" £30,000.
Monte Christo	60,000	66 3	S. 1279·25	" £50,000.
Hawsthorne's	120,000	68 0	S. 1279 35	" £40,000.
Brown's	25,000	45 0	S. 1318·86	" £60,000.
Cook, Aitwood & Dwyers	80,000	57 0	S. 1327·21	" £35,000.
Creighton & Beards / [illegible]mor's	80,000	32 6 29 6	S. 1326·62 S. 1322·55	February, 1872, first crushing about £5,000. No crushing yet, rich stone.
[illegible]gent Lion	27,000	34 0	S. 1326·50	First crushing about £2,000.
[illegible]'s	160,000	124 6	S. 1342·78 S. 1342·29	About £30,000.
[illegible]f Peace	84,000	158 0	S. 1253·30	
[illegible]er & Beard's	60,000	126 0	S. T.M. 1233·57	Not known.
[illegible]'s	50,000	90 0	S. 1396·32	About £6,000.
[illegible] & Co.	25,000	59 0	S. 1343·05	
[illegible]	20,000	60 0	S. 1401·22	
[illegible]'s / [illegible] Star — Now Crown Prince United Company	26,000 12,000	127 0 67 0	S. 1319·17 S. 1361·35 S. 1360·16	
		a. r. p.		
[illegible]ation / [illegible] Prince	....	0 0 25½ 2 1 1½	S. 1394·06 S. 1376·32	
[illegible] & Try (Patriarch)	48,000	1 3 32	S. 1414·79 S. 1384·13	
[illegible]	12,000	0 3 7½	S. 1430·70 S. 1407·72	
[illegible]stone	25,000	1 0 34½	S. 1431·87 S. 1452·58	
[illegible]mann's	24,000	0 2 32½	S. 1444·39 S. 1436·96	
[illegible]bsberry	.....	0 3 12		
[illegible] Western	10,000	1 3 28	S. 1430·24	
[illegible] (Cornelius)	24,000	2 2 0	S. 1452·94	
[illegible] Northern Amalgamated	.....	3 2 31	S. 1428·14 S. 1453·97	
[illegible]t Exhibition	48,000	4 3 8½	S. 1537·36	
[illegible]well's	12,000	0 0 16	S. 1408·67	
[illegible]t Western Undaunted	40,000	3 3 21	S. 1292·21	

S = Shaft; T.M. = Tunnel Mouth.

The width of leases and levels are taken from the map compiled by Messrs. Cowdery Bros., published 20th December, 1872.

The above table shows the nominal capitals fixed in prospectuses issued in the early part of 1872.

The table gives an idea of the enormous capitalisation for gold-mining purposes of the relatively small area on the western slopes of Hawkins Hill.

To summarise the table, it may be stated that the capitalisation amounted to £1,529,000, and the total area concerned to about 700 acres. A similar but smaller area has been again capitalised during recent years for over £200,000.

[1] Jarrett & Co., 100 and 102 Liverpool-street, Sydney, pages 71–72.

Digitized by Google

The following tabulated list has been prepared of the veins worked on Hawkins Hill in the early days, and, although the information is very incomplete, and only approximately correct, it may be of interest, particularly when viewed in the light of the enormous yields from these veins, which Mr. W. Marshall has estimated at over 30 tons of gold :—

TABLE A.—TABLE OF THE PRINCIPAL VEINS WORKED ON HAWKINS HILL.

Name of veins (from west to east).	Length worked.	Depth proved.	Width of veins.	Number of veins.	Stoped ground.	Yields.	Remarks.
Lady Belmore	300 feet	200 feet	6 to 8 inches	One	From grass to 200 feet	Up to 7 oz. of gold per ton.	
Brand and Fletcher's	100 ,,	250 ,, ...	6 inches	,, ...	,, ,, 250 ,,	Up to 5 oz. of gold per ton.	The richest makes of ore were obtained where a spur came in from hanging wall.
Amalgamated or Philipsons.	300 ,,	About 900 feet (Carroll and Beard's Shaft).	8 ,, ...	,, ...	100 feet below Amalgamated tunnel for length of about 60 feet.	From 8 dwt. to 2 oz per ton.	This vein reaches surface a little above the Amalgamated tunnel.
West Workings (Mica Vein or Beyers and Holterman's).	2,100 ,,	About 750 feet	From 1 foot to less than half an inch.	Three	700 or 800 feet on the chute from grass roots down.	Phenomenal as a rule.	In places a series of quartz veins and bands of slate all taken out for width of 14 feet when the following vein was reached
Star of Peace	2,000 ,,	765 feet	From 2 to 6 inch	From three upwards.	From grass to 500 feet ..	,, ,, ,,	In places a series of quartz veins and bands of slate all taken out for width of 14 feet when the following vein was reached (right across to the west workings 14 feet).
Middle Workings ..	1,200 ,,	300 ,, ...	Up to 14 feet	Quite a number at times.	,, ,, 300 ,, ..	Up to 900 oz. per ton (two tons yielded 4,600 oz.)	The veins were not so rich at the southern end of the line.
Paxtons'	1,500 ,,	500 ,, ...	Total of 5 ,, ...	Three veins	,, ,, 500 ,, on the chute 200 feet high.	From ½ oz. up to 2,300 oz. per ton.	Even in the chute occasional blanks occurred.
East Vein	300 ,,	400 ,, ...	3 inches	One	Down to 200 feet	4 oz. per ton	The stoped ground was confined to one gold chute.
Moustaka's	30 ,,	400 ,, ...	"Blow" 30 feet and Vein 6 inches.	.....	Blow only to 300 or 400 feet.	Low grade	The bulk of the stone crushed came from the "blow" or pipe in Fisher and Beard's shaft.
Herman's	300 ,,	400 ,, ...	8 inches with "blows."	.....	300 feet long on chute..	Up to 14 oz.	
Frenchman's	200 ,,	180 ,, ...	8 inches to 10 inches.	,, (with blows)	.....	3 to 4 oz.	The "blows" were most pronounced at southern end.
Rowley's or Daddy's	400 ,,	160 ,, ...	3 inches	,, ...	400 feet x 160 feet x 3 inches.	Up to 60 oz.....	Low grade as followed north (an inverted saddle reef in Devonian rocks; thinned out on reaching apex of syncline).
Mountain Maid	150 ,,	60 ,, ...	2 inches	,, ...	150 feet x 60 feet x 2 inches	Up to 12 oz	Low grade as followed north (an inverted saddle reef in Devonian rocks; thinned out on reaching apex of syncline).

Digitized by Google

The chutes of gold all appear to have been pitching to the north in the upper levels, but stoping done of recent years from the Amalgamated tunnel proves that the chutes worked in the Star of Peace and Mica veins are pitching south at an angle of about 20 degrees.

For more detailed information concerning the old workings the reader is referred to the excellent set of mine plans prepared by Mr. Surveyor Parrot, published in the Annual Report of the Department of Mines for 1887.

About 1 mile in a westerly direction from Hawkins Hill, on the west side of Hill End Creek, two lines of reef, bedded in Devonian strata, dipping to the west at a steep angle, have been worked in the past; Marshall's and King's operations were started on the former during the year 1872, and continued until 1874, when it was abandoned, but reopened again in 1883, and worked at intervals until 1885.

The shaft has been sunk to a depth of 300 feet, and the reef, which was never very wide, had dwindled to about 1 inch of quartz at the bottom level.

It was stoped in places down to the 200-feet level, over a length of about 150 feet, and some good but small crushings obtained, 16 oz. of gold having been won from 2 tons of ore.

King's reef is slightly to the east of Marshall's line, but never proved encouraging, and very little work was done on it.

Coming back to the main auriferous belt of Hawkins Hill, the following mines have, or are now being worked north from the head of Nuggetty Gully.

The Hawkins Hill Reward G.M. Co.

As this company was only formed during 1909, and is still working, it will be dealt with under the heading "Recnt Mining Oprations," on pag 47.

The Scandinavian.

This claim was first worked about 1873, the main shaft being sunk to a depth of 200 feet, levels driven north for 200 feet and south for 300 feet, and a crosscut put in for 200 feet to the west, connecting with Carver's reef workings. There is every reason to believe, from the surface geological formations, and the bulk of the material in the dump, that the levels, and probably part of the crosscut, were driven in the younger rocks, and no satisfactory returns were obtained. Certainly the main shaft was started in the Ordovician beds, and the surface contact swings to the west both north and south of the shaft. Had the shaft been sunk deeper, and crosscuts east and west then put in, there is no doubt that a wide belt of Ordovician rocks would have been prospected; but whether they contain auriferous reefs has yet to be proved.

Carver's Reef.

About 200 feet west from the Scandinavian Company's shaft, a line of reef, known as Carver's, was worked about the year 1880.

The vein was only from 4 to 6 inches thick, and yielded from 3 to 5 oz. of gold per ton. Three or four claim-holders worked on this line, and stoped out the reef to a depth of about 200 feet over a length of 700 or 800 feet.

The ground is now included in the Deep Levels Hawkins Hill Gold Mining Company's property (see page 51).

Digitized by Google

Continuing north from the Scandinavian, across Hill End Creek, and ascending Sargent's Hill, the following information was obtained regarding the old mining ventures:—

Before crossing the creek, the Lombard-street Mine is seen on the southern bank. This shaft penetrated 200 feet of the Ordovician strata and crosscut east for 200 feet, and west for the same distance.

A number of small veins were cut, but none of them were payable.

In fact, the available evidence with regard to this narrow belt of country in the immediate vicinity of Hill End Creek goes to show that it never paid to work. At the surface the exposed Ordovician rocks consist of grey slates and schistose rocks, differing lithologically from the main gold belt, but at a greater depth conditions may have altered owing to the easterly dip of the beds.

Close to the road from Hill End to Spring Creek, &c., is the Eureka shaft, sunk to a depth of 200 feet on a vein called "Sargent's," but subsequently known as the Excelsior. There appears to have been a fair amount of work done here, the last crushing having been made about 1878, 7 tons of ore yielding 60 oz. of gold. The Excelsior was the next claim, in which the shaft was sunk to a depth of 300 feet, and excellent returns obtained from the stone crushed.

There were a number of other claims along the strike of this reef (Sargent's), the cap of which yielded many thousands of ounces of gold. McPherson's shaft was sunk on this line to a depth of 180 feet, and good returns obtained; but a crosscut driven west for 70 feet appears to have been entirely in Devonian rocks, and proved no values.

As Sargent's Hill is ascended, over the scene of the first reef-mining in Australia, numerous old workings are seen, but it was not possible to correlate the various veins worked.

The Blockers was the name applied to a vein east of Sargent's, and very rich yields were obtained down to a depth of about 100 feet; in fact, it is stated that the stone was frequently literally hinged together with gold. A little further north, Ackerman's vein was worked by a vertical shaft, 305 feet deep, cross-cuts being driven west for 30 feet, and east for 100 feet, the yields being up to 200 oz. of gold to the ton.

East of this mine, Meyer's vein was worked to a depth of 200 feet, with cross-cuts east and west at several levels, in which numerous rich veins were cut.

The Royal George shaft was sunk to a depth of 210 feet, and connected by a drive at 160 feet to a vein known as Ackerman's, some 160 feet away.

West of the Royal George was a claim known as the Proprietary, a very rich patch being struck in Sargent's reef, and worked down for about 100 feet.

The veins appear to have been named somewhat indiscriminately on this portion of the field, and it is now impossible to identify any particular line continuously. The writer's impression of the succession of veins from west to east towards the crest of the hill is:—Dragon, Venus, Ackerman's, Meyer's, Blocker's, Mullocky, Bridges', and Sandpaper, and that Sargent's reef, or the Excelsior, was the name applied to the most westerly vein at the foot of the hill.

Several shallow depth tunnels were driven across the hill in places, notably "Graham's" and "The Frenchman's," the former from daylight to daylight, and the latter through to the Excelsior workings.

Digitized by Google

The age of the beds cropping out on this hill is by no means clear, but the writer inclines to the belief that they belong to the younger series, although very much crushed, altered, and decomposed.

It seems probable that much of the mining on Sargent's Hill has been carried out on the caps of bedded reefs in the Ordovician rocks, after they had passed into the Devonian capping. An occurrence fitting in with this suggestion is seen on the Lady Belmore reef on the south-west slopes of Hawkins Hill.

As bearing upon the age of the Sargents' Hill beds, attention is called to an exposure right in the bed of the creek below the Blockers shaft. Here a narrow "V" of undoubted Ordovician rocks extends up the creek, and disappears beneath the land surface.

One of the biggest drawbacks to the miner on this hill appears to have been the excessive flow of water encountered at comparatively shallow depths; and until this is overcome, say by the tunnel scheme referred to in this work, there does not appear much chance for the miner.

After crossing the road to the Recreation Reserve, on the eastern slopes of Sargent's Hill, a number of old shafts are to be seen, but apparently nothing of any value in the shape of auriferous reefs appears to have been proved here. About a quarter of a mile further north, and on the western slopes of the hill, the Golden Gully line is reached. This line of reef is situated on the right-hand bank of Golden Gully Creek, about half a mile below the divide between it and the waters of Hill End Creek.

The reef occurs close to the western contact between Ordovician and Devonian beds, and may represent a contact reef; but the writer was unable to see either the reef or true walls. Certainly, judging by the dump heaps, rocks of both ages were penetrated, but whether the Devonian material came from westerly cross-cuts is not ascertainable. The line of reef appears to have been worked almost continuously for over half a mile in length, and in places down to a depth of about 200 feet, and very rich yields obtained during the years 1870 to 1880.

On the western fall from Hill End, and about 2 miles north-west of the village, several reefs were prospected, notably Bridge's, Jeffries', and Washing Gully, but no great amount of work was done, and only one or two small pockets of payable stone were taken out. All these veins are undoubtedly in the younger rocks.

Numerous other claims were prospected between the Golden Gully line and Tambaroora, the principal being the Black Watch, Canton, Cremorne, Magnet, and Independent. All these reefs are in beds of assumed Devonian age, and probably represent the legs of saddle reefs. They decreased in thickness as followed down, values became less, the country very hard, and in very case the inflow of water stopped further profitable work.

The Black Watch.—This reef was up to 6 inches wide, and was opened up to a depth of 200 feet and a length of 400 or 500 feet of ground stoped out, but results were never very encouraging.

The Canton was worked to a depth of 150 feet, and the reef (8 inches wide) stoped out over a length of 600 feet right to the grass roots. In the early stages this reef yielded values of over 10 oz. of gold per ton, but gradually became poorer, so that hard country and inflow of water led to its ultimate abandonment.

Digitized by Google

The Cremorne reef had a maximum width of 6 inches, and was worked to a depth of 200 feet, a length of 400 feet being stoped out to grass roots. The earlier returns averaged about 1 oz. of gold to the ton, but values had very much decreased when the mine was abandoned.

The Magnet.—This was the name of a mine operating on a reef with a maximum width of 4 feet, and averaging about 2 feet, yielding from 5 to 6 oz. of gold per ton. It was worked down to a depth of 200 feet, and the reef stoped out over a length of 600 feet, but eventually abandoned.

The Independent shaft was sunk to a depth of 300 feet on a short narrow reef, 4 inches wide, and only about 40 feet long. Values were good (from 10 to 100 oz. of gold per ton), and are reported to be still going down, but the water difficulty caused the mine to close up.

The Britannia was the name of a claim working a reef from 6 to 8 inches wide, the average yield being 3 oz. of gold per ton. The main shaft was 160 feet deep, and the reef was stoped out over a length of 300 feet.

About half a mile west of Tarbaroora, on the low rise on the western side of Golden Gully, surface work was done on one or two saddle reefs, but the gold contents did not go down, and there was no encouragement for further prospecting.

The Red Hill Mine undoubtedly attracted great attention, and from the evidence available appears to have produced a large amount of gold.

Some thirty years ago a company secured the property, and worked it on a large scale. It would appear that a very large tonnage of ore was treated, and the returns are reputed to have been "tens of thousands of ounces" of gold.

The main shaft is down to a depth of 430 feet, and the reef has been stoped out along a length of 1,500 feet, but only on the chute of auriferous stone, which was about 20 feet high, rising to 40 feet in places, and 4 inches wide. This chute pitched persistently to the north, and was worked both north and south from the main shaft.

Whatever the cause, presumably the loss of the auriferous chute, the company closed down, but the ground was again taken up by an English company, about twenty years ago, with a capital of £50,000. This company did no good, however, attention apparently having been devoted more to securing tonnage than gold returns, with the result that the mine was abandoned in 1899.

There were a number of other claims working on the Red Hill in the early days, and although some rich gold chutes were taken out, nothing permanent developed.

About half a mile north of the Red Hill Mine a series of reefs in Devonian rocks have been worked to a limited extent. These are known as the Valentine, and work started here some thirty years ago. The main shaft is down 175 feet on the underlay, and levels have been driven north for about 200 feet, and south for 150 feet. Several veins were tried, their proved outcropping length being about 100 feet; and on the surface some very rich returns were obtained, said to be up to 35 oz. of gold to the ton. The vein-stuff was principally quartz and calcite, and the country rock slates and tuffs with crystals of arsenical pyrites and calcite. The reefs were about 3 feet wide at the surface, but pinched at a shallow depth, and values were too low to pay when the mine closed down. A little work was

Digitized by Google

Digitized by Google

Digitized by Google

done during 1915-16, but no inducement to continue appears to have been met with. It is evident that these veins formed the eastern dipping legs of saddle reefs.

About half a mile north of the Valentine another small area of auriferous country is met with, known as the Golden Belt. Very little work appears to have been done here, and no information regarding it is available.

Continuing north for about another half mile, "The Old Company's" ground is reached (referred to on page 11). Several shafts have been sunk on reefs striking approximately east and west, and an examination of the area proves them to be on the apex of the western anticline in the Devonian rocks. No information is available, but, judging by the tips, no great amount of work was done.

The Hawkins Hill Reward Gold-Mining Co.

This company was formed during 1909, with a nominal capital of £20,000, and purchased an area of ground on the crest of the hill between Hill End and Nuggetty Gully, including the old Emmett and Hughes claim. This claim had worked an east and west make of stone, supposed to be in a fault plane, and some very good returns were obtained during 1890-92.

The Robert Emmett shaft had been sunk to a depth of 170 feet, and the reef stoped out to grass roots over a length of 80 feet. During 1909-10, the Hawkins' Hill Reward Company unwatered and repaired the main shaft, and sunk a winze to a further depth of 30 feet; but the water difficulty proved too great, and work was abandoned there.

The old Exhibition Company's shaft, sunk to a depth of 420 feet in 1872, and included in the present company's ground, was then cleaned out, also the Cornelian shaft, which was connected through the Patriarch workings to the Consolidated tunnel.

A level was driven north from the Cornelian shaft to the Exhibition shaft at 320 feet, thus enabling the water difficulty to be overcome by drainage through the Consolidated tunnel. Crosscuts were driven east from the Exhibition shaft, and reefs corresponding in part to the Frenchman's worked north for 400 feet and south for 500 feet at the 220 and 320 feet levels. About 10,000 tons of ore were raised up to 31st December, 1917, for a return of about £40,000. The mine is equipped with a twenty-head stamper battery, but only fourteen are at present in commission, also a boiler and winding engine at the Exhibition shaft. Concentrating tables are not necessary, as practically all the gold is saved on the plates, the gold contained in the mineralised portion of the ore being fairly coarse and free.

The Exhibition shaft was started in rocks of Devonian age, but the Ordovician beds were reached somewhere above the 120 feet level. (The shaft is close timbered, so that the contact cannot now be seen there.) The contact is dipping east at about 60 degrees, and is seen at the end of both the 220 and 320 feet level crosscuts. Very pronounced quartz reefs, at times making into "blows," were located, and the levels driven along them both north and south.

The contact zone swung round to the west a short distance on either side of the main crosscut, at the 220-feet level, and about 240 feet north in the 320-feet level. The makes of quartz worked struck a little east of south and west of north, the main bodies passing from the contact zone into the Devonian beds, particularly in the northern levels. Towards the north end

Digitized by Google

of the 320-feet level they died out entirely, but are still of large size at the south end, although values have decreased. It is considered that the make of quartz exposed in the stopes above this level will yield about 10 dwt. of gold per ton. The width of this make is about 20 feet, and it has been followed south in the level for about 60 feet, at times reaching a width of 80 feet, where the workings are spoken of as the Cathedral and the Church. The most westerly make of quartz in the crosscuts is 4 inches wide, and here it appears to be a true bedded reef in the Ordovician strata; but when it strikes the contact zone it widens out, and gold values increase very much.

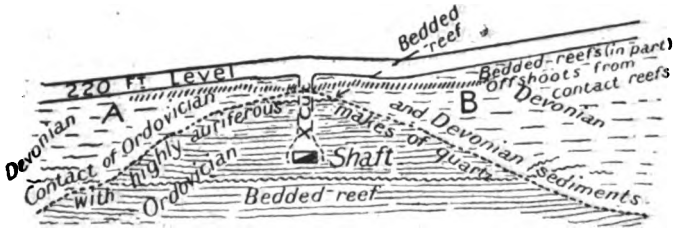
Some of the makes of quartz leave the contact, and pass into the Devonian strata, being more or less interbedded with it, but in places form a regular stockwork of veins. In both cases there has been considerable replacement of the country rock by quartz. These occurrences had been proved to be dying out in length, and gold values were very patchy.

The writer expressed the opinion that the same thing would happen at no great depth, an opinion based on the behaviour of reefs worked in Devonian strata in various places over the field. This was subsequently proved to be correct in some of the underhand stopes from the 320-feet level.

As described on page 68, the contact zone should theoretically have offered favourable conditions for the deposition of lode material; and, moreover, investigations over other parts of the field proved this to be the case, and that these lodes were enormously rich in places.

The company have in the past been carrying out most of their work at the north end on off-shoots from the contact, entirely in Devonian rocks, in which the reefs almost invariably have no persistency, and conditions for precipitating the gold contents of circulating waters were most patchy.

The following sketch plan illustrates the conditions pertaining at the 220-feet level:—



In the light of this opinion, the management was advised to put in a crosscut to the west at A or B, with a view of again getting in touch with the contact, where makes of pay ore should theoretically be expected. This was done in both cases, and a quartz reef from 2 to 3 feet wide was proved, carrying free gold and mineral, but very much richer at A. The crosscut at B was only 4 feet in when the reef was struck, and at A the cut is about 3 feet in to the reef, the two points being about 75 feet apart, whilst A is 18 feet lower than B, so the prospects look good for a fair body of milling ore being obtained.

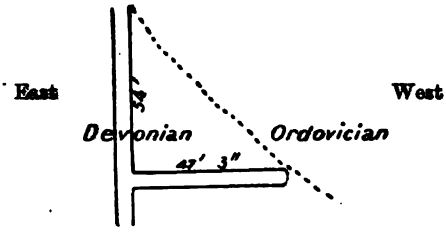
The first crushing yielded about 4 oz. of gold per ton, and the reef is improving very much in values underfoot at the south end. This is undoubtedly a case in which theoretical deductions are absolutely upheld by

Digitized by Google

the results obtained. During a final visit to the field (August, 1918), before preparing this publication, the writer obtained the following latest particulars of this development:—

The 320-feet level was driven along the contact zone on a large make of quartz and slate, both to the south and north. In the former direction the values gradually decreased, but the face still contains about 14 feet of quartz and slate, estimated to yield about 10 dwt. of gold per ton, and apparently in the contact zone; but the writer would suggest a pop-hole or two in the footwall to make sure.

Going north from the main crosscut, the contact leaves the level about 240 feet along it, and swings to the west; but the level was driven straight on in the Devonian beds. A notable feature in connection with this is that up to the point where the contact left the level values were payable, namely, 1 oz. of gold per ton over a width of 3 or 4 feet, and up to 35 feet above the level. Immediately the level entered the Devonian strata, the values ceased, although the make of quartz continued for some distance. Two hundred and ninety-four feet north of the shaft at this level, a crosscut is now being driven west to intersect the contact, but was still in Devonian sediments when last seen, then being 47 feet 3 inches west from the level thus—



The company are urged to continue crosscutting to the west, and if a make of ore occurs this should be followed up by stopes or a "rill" rising to the south. This would then connect with the similar occurrence at the 220-feet level, but further south, and which does not appear to extend as far north as the crosscut under review.

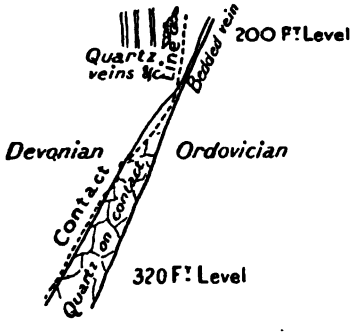
In the 220-feet level south, the contact passes into the footwall 12 feet from the main crosscut, and was reached within 4 feet of the old level. Here a nice quartz reef was exposed, with a width of 3 or 4 feet, but low gold values. Eighteen feet further south another crosscut was put into the footwall for about 5 feet, and a make of quartz with fair values, averaging about 2 feet wide, was proved. Sixty-six feet further south of this again, or 116 feet from the main crosscut, the same make of stone was proved underfoot in the level, and although the width is only about 10 inches, values are estimated to be from 7 to 10 oz. of gold per ton over the short length exposed.

The foregoing shows that, whilst the old level passed out of the contact zone a few feet south of the main crosscut, it was again exposed in the level about 112 feet further south, but here was very pinched with practically no quartz or values. Immediately underfoot, however, conditions altered, and the present make started.

In the same level, north 20 feet, the contact zone passed into the western side of the level, which from this point on is entirely in Devonian rocks right to the face, and either values were low or there was no reef.

Digitized by Google

Forty feet north of the main crosscut an inclined cut or "rill," reaching to a depth of 14 feet below the main level, was driven west for 29 feet 6 inches, and connected through to the 320-feet level on the make of stone worked there; but, whereas this was several feet wide at the 320-feet level, it was little more than an inch or two wide in the cut now being dealt with, and dipped east at 68 degrees. Here it is a bedded vein, but at a lower level passes into the contact zone thus—



A foot or two east of the hanging-wall of this vein a contact between Ordovician and Devonian sediments is to be seen, but there is no quartz present. On the other hand, the Devonian beds, back to over 20 feet from the contact, are traversed by a number of quartz veins, with a slight westerly underlay. Transverse veins and irregular shaped makes of quartz also occur, but gold values are practically nil. For about 15 feet along the old level, but a foot or two behind the original footwall side, a nice make of highly auriferous quartz is now being stoped out, which undoubtedly occurs on the contact plane.

Care should be taken in following this make to keep in touch with the Ordovician footwall, for if this swings slightly to the west, as may be expected, the vein may follow the Devonian bedding planes, and lose its values or pinch out. This make of stone has now been proved over a length of about 130 feet, with a proved height of 20 feet, and still going strong underfoot at the south end, but apparently pinching out some 20 feet north of the shaft, thus indicating a distinct southerly pitch. Later developments (September, 1918) go to show that a lens of ore has been tapped, which will increase its dimensions as followed down.

It should be recognised that this type of occurrence is very liable to be most erratic in strike, underlay, thickness, and extent. It may make into a very wide formation, such as is found in the 320-feet level south, or pinch out entirely, as in the "rill" from the 220-feet level north.

The best values may be expected where a bedded vein in Ordovician rocks strikes the contact and forms a blow. In view of the absence of veins in the main crosscuts, it is evident there are no bedded veins in the Ordovician rocks likely to hit the contact in the present levels, unless it is further north, but at a greater depth such may be expected.

The writer is of the opinion that, on the evidence available, the future prospects within this property are good, particularly once the Amalgamated tunnel passes through it, which will be the case after 300 or 400 feet more driving. With the assistance recently granted from the Prospecting Vote, this work is practically assured, and will be the means of providing a drainage scheme to a depth of over 700 feet. The unwatering difficulty will be economically solved down to the tunnel level, and nearly 500 feet of practically virgin country will be available for prospecting underfoot (320-feet level to tunnel level, say 780 feet).

Digitized by Google

Many of the famous Hawkins Hill veins may reasonably be expected to occur, and that under favourable conditions for the occurrence of payable ore bodies, namely, a pronounced fault plane system known as the Robert Emmett cross-course, kindly black slates and "droppers," or "indicators," &c.

The contact zone, in which rich makes of ore may be expected, also offers big probabilities; and if the mine is worked systematically, and development work kept well ahead of stoping, good results should be obtained. If tonnage is to be kept up to the battery, this development work is a vital necessity, where the veins may be narrow and blanks occur in the reefs.

The Patriarch shaft will be available for raising ore and mullock, for although it is in the Central Company's ground, the majority of shareholders in either company are common to both, so that friendly arrangements will probably be easily arranged.

During 1918 the company was reconstructed and amalgamated with the Golden Key property adjoining it on the north (Old Scandinavian). The new company is known as the Deep Levels Hawkins Hill Gold-mining Company, the capital of which is £37,500, divided into 100,000 shares of 7s. 6d. each.

Until the Amalgamated tunnel reaches the northern portion of the ground held, no prospecting work can be done there owing to heavy water; but the company are strongly urged to drive a crosscut west from the 320-feet level right across the belt of Ordovician rocks. This will prospect any reefs which should occur there, and also prove whether conditions are favourable for the occurrence of gold chutes on the western contract zone, for the writer is of the opinion that the Sargent's Hill series of reefs will be cut. If this prospecting work proves the occurrence of auriferous veins, there would be three or four hundred feet of backs available for economic working.

The Amalgamated Hill End Gold-Mining Company.

During 1909 a company was formed to again work the main Hawkins' Hill belt. This company purchased or secured the mining rights over some hundreds of acres, and had a capital of £100,000 in 500,000 shares at 4s. each.

Work was commenced in an old tunnel, known as Carver's, which had been driven into the hill at different periods from 1872 to 1911, for a distance of 700 feet. (For position see plan, page 47.) Several reefs had been cut and driven on, and where values were proved a certain amount of stoping was done. No detailed information regarding the ground stoped, or returns obtained, are available, but it is estimated that a length of about 400 feet was stoped out to a height of 100 feet on Paxton's reef.

The Amalgamated Company repaired the tunnel, and pushed the main drive on for about 1,000 feet north, in addition to crosscutting and driving on various veins. (See plan, page 47.) This tunnel was only about 350 feet below the collar of shafts from which the various veins were worked during the "seventies," and several of these shafts had penetrated to a much greater depth, notably Carroll and Beard's and the Star of Peace.

Digitized by Google

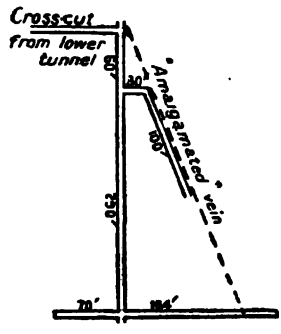
Only a comparatively small tonnage of auriferous material was crushed, and the battery of eighteen head of stampers, near the mouth of the tunnel, was kept going largely in crushing the old dumps, none of which paid. This is hardly to be wondered at, for the dumps had been picked over and over again by the individual miner, and only the valueless stone left.

In 1912 the company decided to drive a new tunnel near the bed of Nuggetty Gully, 300 feet below Carver's, or the Consolidated tunnel, as it is now called.

Plan 4 shows the work done in this tunnel up to about the middle of 1918, whilst the longitudinal projected section (B) indicates the ground stoped out on by this company on the Mica and on Star of Peace veins.

Here again it was subsequently found that Carroll and Beard's shaft (vertical), which was reached by the tunnel workings, had been sunk to a depth of 290 feet below the tunnel level, and a crosscut driven east for 160 feet. This work, which was carried on up to 1881, had resulted in only one of the most westerly of the Hawkins Hill veins being cut (Amalgamated), which was stoped out for a length of 100 feet and down to a depth of 100 feet by means of a winze from the main shaft. Payable returns were obtained, but no sensational makes of gold occurred.

The following section illustrates the work done in this shaft below the tunnel level.



As already pointed out (page 34), two tunnels had previously been driven below the Amalgamated, the principal being Foster's Amalgamated, about 120 feet lower and further south (see page 34), which had been driven for about 1,200 feet into the hill. This ground was held at the time the Hill End Amalgamated tunnel was started, but apparently the owners were not prepared to come to reasonable terms.

It is unfortunate that this was the case, for the company not only incurred the expense of driving a new tunnel, but appear to have penetrated a zone in which most of the old veins were not payably auriferous, and the new veins proved had not become fully developed. During 1912 the company received aid from the Prospecting Vote to sink a shaft ("Government shaft" on Plan 4) on the Star of Peace vein, from the tunnel level to a depth of 150 feet. The shaft was sunk to the full depth, and a crosscut driven west for 30 feet to cut the Mica vein, which was driven on north for 180 feet, and crosscuts made back to the Star of Peace vein, 80 feet north from the shaft, and at the end of the level, the distance separating the veins at the north end being 18 feet.

Results were not encouraging, and another level was driven south for 36 feet on the Star of Peace vein, 50 feet above the bottom of the shaft, to intersect Beyers and Holterman's cross-course. About 11 feet along this level a big quartz blow was reached, with a width of 10 feet, and striking south-east and north-west. The blow feathers out at the face into numerous thin bedded veins.

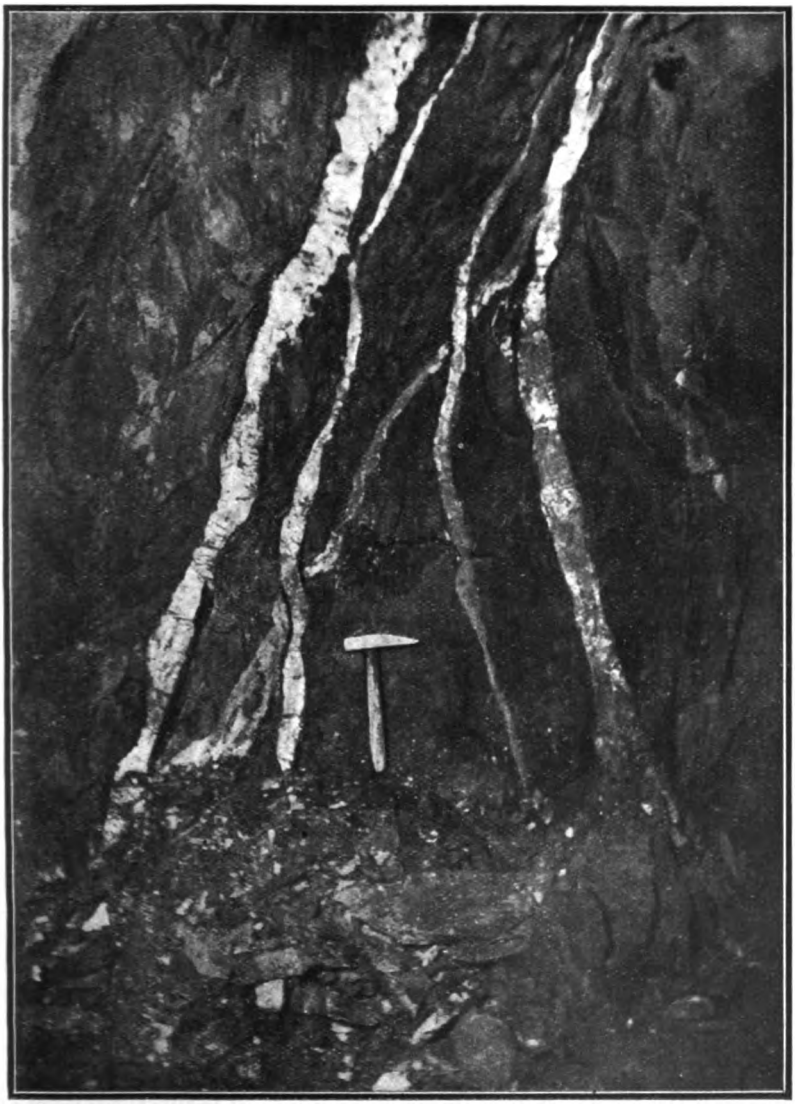
Digitized by Google

Ground sto

Digitized by Google

Digitized by Google

PLATE IX.



"Amalgamated" veins, Amalgamated tunnel, Hawkins Hill.

Digitized by Google

Digitized by Google

A similar occurrence had been worked 100 feet higher up, in the main tunnel, with very good results, 5 tons of quartz yielding 100 oz. of gold, but at the deeper level the values were not enough to pay. Funds then ran short, and work was abandoned. It seems a pity that the money spent here was not devoted to bailing out Carrol and Beard's shaft below the tunnel level, and continuing the crosscut east to intersect the main veins, some 300 feet lower down. This would have resulted in prospecting work being carried out on these veins at the deepest level reached on the field, and also of testing the new veins just making at the tunnel level.

The Amalgamated Hill End Company persevered despite numerous disadvantages, not the least of which was the necessity of sending firewood and mine timber from the top of the hill down to the engine and battery or lower tunnel by two "flying-foxes" (see plate VIII), the top one of which has a drop of 320 feet, and the lower of 300 feet. Ore won from the lower tunnel has all to be hauled up by the lower "fox" 300 feet to the battery.

Since 1914 Mr. E. Cock has been in charge of the mine, and there is good reason to believe that had he been in charge from the initiation much more favourable results would have been attained.

An enormous amount of work has been done, and it is to be regretted that results were not more favourable; but the managing director, Mr. J. E. Scantlebury, although not making a success of the venture, has conferred a permanent benefit upon this gold-field, for the lower tunnel will no doubt be continued north, and thus unwater a large portion of the field down to a depth of some 800 feet to the north of Hawkins Hill.

This company had spent over £52,000 up to the middle of 1918, nearly £40,000 of which was capital, and about £13,000 being the value of the gold won.

In June, 1918, the Amalgamated Hill End Gold-Mining Company contracted to dispose of their interests to Marshall's Hill End Gold Mining Company, the capital of which is £15,000 in 75,000 shares. The old company retained a tribute right for two years to work the Star of Peace and Mica veins series below the tunnel level, the new company being allowed that time to complete the purchase.

The tributors have sunk a winze to a depth of 50 feet on the Mica vein, and opened out a very nice make of pay ore. Stoping is now going on off the winze on excellent values, particularly in the vein itself, which varies in width from a mere thread up to 9 inches. There are two or three veins in the Mica vein channel, and gold occurs not only in the quartz makes, but also in the adjoining slates, so that it pays to take out the full width between the walls, which averages about 3 feet.

Specimens of the actual vein-stuff (footwall) are estimated to yield over 2,000 oz. of gold per ton, whilst the full width taken out will return about 3 oz. of gold per ton.

This is the greatest depth to which the Mica vein has yet been worked, and although the extent of the gold chute has not yet been proved, it is interesting to note that the high values are still going down.

The present company are devoting most of their attention to pushing on the main level, and aid to the extent of £1,000 has been granted from the Prospecting Vote to continue the level 1,000 feet further north. At

Digitized by Google

present the level is penetrating ground held by the Hawkins Hill Central Gold-mining Company, and it within about 200 feet of the Hawkins Hill Deep Levels Company's lease; but, as already pointed out, the controlling interests in all three companies are almost identical. Reference has been made to Carroll and Beard's shaft, and the existing crosscut east therefrom (pages 14 and 52).

The writer strongly urges the present company to clean out this shaft and continue to crosscut east to the contact zone. By this means all the Hawkins Hill veins will be prospected at a greater depth than the present deepest workings, that is, 150 feet below the Government shaft, which resulted in two veins only being tried. Moreover, the new veins located near their apex in the Amalgamated tunnel workings may prove to be payably auriferous at this depth, and the possibilities along the eastern contact are not to be ignored.

The pitch of the gold chutes worked by the old company is to the south in every case, that in the mica vein now being worked on tribute is south at 20 degrees, so that any of them might extend down to the crosscut in question. The inflow of water is not likely to hamper this work, for it is reported that when abandoned the shaft and crosscut were practically dry.

The Hawkins Hill Central Gold-mining Company.

This company was formed during 1915 with a capital of £37,000 in 250,000 shares at 3s. each.

The position of the leases with regard to the existing adjoining companies is hown on plan 4, facing page 47.

An excellent three-compartment shaft is down to a depth of 500 feet, from the bottom of which cross-cuts have been driven east for 170 feet and west for 70.

The western cross-cut exposed what is assumed to be the Mica vein, which was driven on south for 50 feet, the yield from which was from 2 to 3 oz. of gold per ton over a width of about 6 inches.

During a strike in 1916 the workings became flooded, and have only recently been unwatered, so that the amount of work done by this company is negligible as far as the shaft workings are concerned.

A vein, thought to correspond with the Star of Peace, was also cut in the western drive, but values were low in the short length of vein seen.

The eastern cross-cut penetrated a perfect network of quartz veins and leaders, some of which payed to stope out. The writer was unable to examine the eastern portion of the cross-cut, as it had been filled with mullock; but it is probable that the contact between Ordovician and Devonian strata was penetrated, judging by the surface evidence.

About 100 feet east from the foot of the shaft a comparatively narrow belt of a coarse tuffaceous rock was penetrated, and this may represent a narrow gully in the Ordovician beds, which has been filled up with Devonian sediments. It was not possible to examine this occurrence with any detail, as the workings had only just been unwatered, and rock faces were largely covered with mud, whilst the ground was so rotten that the hammer could only be used with the greatest caution.

Digitized by Google

"Indicators," or "droppers," are most marked in this cross-cut, and Mr. Harry Graham, who worked in many of the old claims, considers conditions identical with those found above the rich gold chutes in other parts of the field.

It is thought that some, if not all, of the vertical droppers represent a slight movement along cleavage planes, with which they appear to coincide.

The cross-cut has been driven on the Patriarch cross course or vertical fault, which has caused a horizontal displacement of about 6 inches.

That there was considerable reciprocal movement on the plane of the fault is evidenced by the quantity of contained dig or clay, which is over 2 inches thick.

Possibly a sympathetic movement took place on some of the cleavage planes, thus causing the formation of the soft dig filling found thereon.

In this cross-cut are found all the factors almost invariably associated with the rich gold chutes on Hawkins Hill, namely:—A pronounced fault plane, numerous "droppers" or "indicators," and kindly bluish-black slates.

The work done in the past appears to have been above the northerly pitch of the main Hawkins Hill gold chute as worked in the past.

This had a height of about 80 feet, and was reached at a deeper level in each succeeding claim to the north. The Amalgamated tunnel is 200 feet below the bottom of the Patriarch shaft, but values at that depth in the Central's ground were somewhat low in the vein driven on. Of course, better results may be obtained from one or other of the parallel veins, and this possibility is now being investigated by cross-cuts from the tunnel.

In the light of the foregoing evidence prospects are encouraging within the 200 feet of solid ground below the Patriarch shaft.

One of the conditions upon which the recent aid was granted from the Prospecting Vote, to drive the tunnel a further 1,000 feet north, was that this shaft must be holed through to the tunnel level for ventilation purposes, and this can be done in either of the following ways:—

1. Winze down on the mica vein to the stopes about 150 feet further south, and 120 feet deeper.
2. Sink the shaft the extra 200 feet, and connect direct with the tunnel.

The first may seem the cheaper at first sight, owing to the lesser amount of sinking (120 feet, as against 200 feet in the shaft). Also, there is the possibility of the winze being on payable ore all the way.

On the other hand, sinking the winze will entail extra handling of the mullock, and in addition to the main shaft winding gear another would have to be installed over the winze, and the ore or mullock trucked from one to the other.

Again, on the winze reaching the necessary depth, a level would have to be driven south on the vein for about 150 feet to connect with the stopes, or else wait until they reached the winze.

Only one vein would have been proved, and if values were not payable the work would serve only one purpose, that is, a ventilating connection. Even this latter would be unsatisfactory, however, for the air will have to travel along a cross-cut for 25 feet to the mica vein, along that level for about 50 feet, down a winze approximately 120 feet deep into the stopes 90 feet above the tunnel, and then return about 200 feet along the level before it is again under the Patriarch shaft.

Digitized by Google

It will still be about 250 feet from the present face, and as the tunnel is extended the air will have to travel further and further. Under these conditions there is a probability that the extra 1,000 feet will not be driven owing to lack of air.

On the other hand, if the Patriarch shaft be sunk (not necessarily the full size at present) the additional 200 feet, most of the following veins will be cut, namely:—Mica, Star of Peace, Phillipson's, and the Amalgamated, and the best and cheapest means of prospecting them be available. Moreover, it might be pointed out that the shaft will be on a fault plane the whole way, in ideal cheap country for sinking on.

The air connection will be direct, and facility afforded for hauling ore and mullock from all the new workings in the Amalgamated tunnel instead of trucking it out over half a mile.

There is no doubt that once this shaft is sunk to the tunnel level all necessary plant can be installed at the head of the gorge instead of, as at present, sending firewood and mine timber down over 600 feet by two "flying foxes," and hauling ore up again.

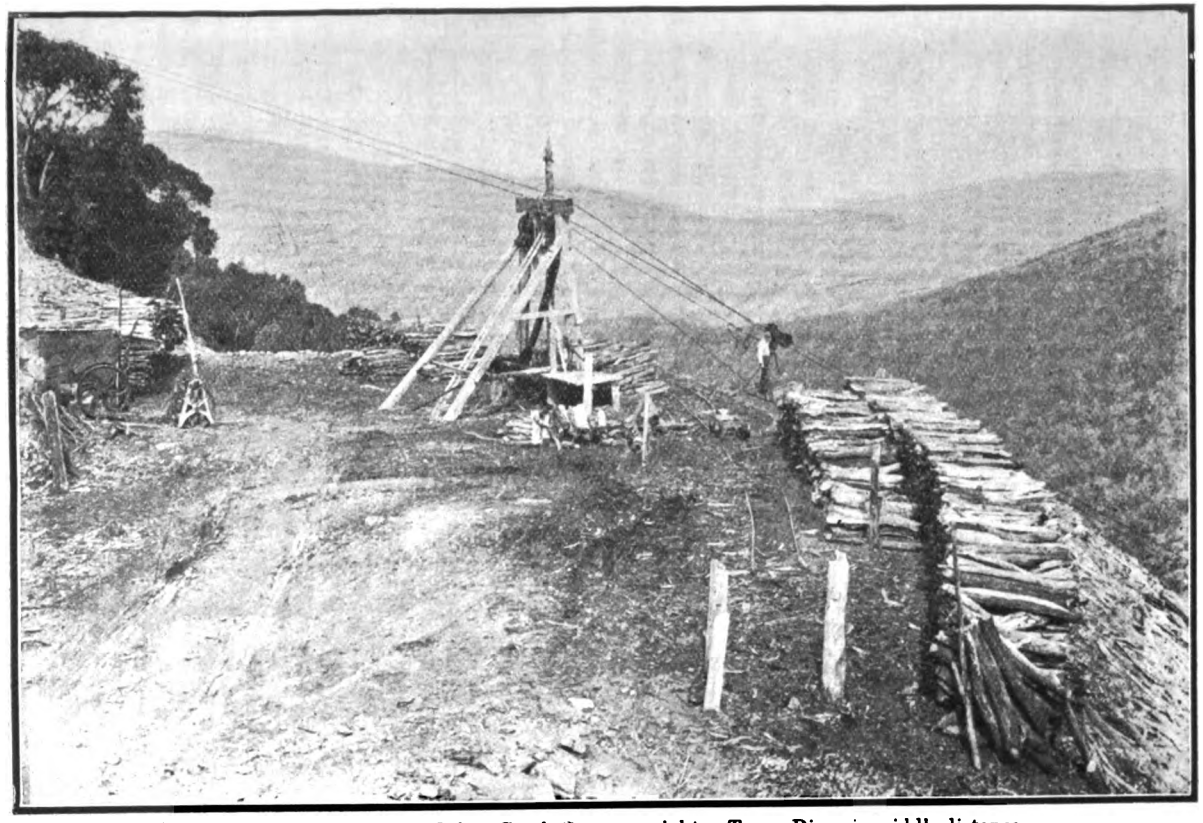
As all three companies will be benefited by this scheme, it is reasonable to assume that the costs would be borne proportionately.

Other important prospecting work which should be borne in mind by this company is as follows:—

1. Clean out the eastern cross-cut in search of the contact zone, and if indications are favourable, as they should be, to drive along it for a short distance either way, but preferably north, for the make of pay ore now being worked in the adjoining Reward mine certainly pitches south towards the Central ground.
2. Continue to cross-cut west from a convenient level to intersect the westerly veins proved on Hawkins Hill, and any other veins [Sargent's Hill series (?)] which may reasonably be expected, but have never yet been searched for in this belt. Also, the possibility of finding highly auriferous makes of stone on the western contact—another chance which has never been investigated on the field.

Since writing the above the company have commenced sinking the Patriarch shaft through to the Amalgamated tunnel level, so that favourable results may be expected shortly.

Digitized by Google



Top Flying-Fox Gantry. Oakey Creek Gorge on right. Turon River in middle distance.

Digitized by Google

Digitized by Google

CHAPTER V.

THE REEFS.

Genesis.—An outline of the genesis of the quartz reefs on this field has been given on pages 21, 22, but it may be advisable to epitomise it here, and also enter into more detail.

The succession of events as interpreted by the writer may be summarised as follows:—

1. During Pre-Carboniferous times, the Devonian beds were folded, and pre-existing folds in the Ordovician strata were accentuated.
2. This caused openings to form along the bedding planes of both ages of rock, as well as minor cracks and fissures.
3. Then followed intrusions of Pre-Carboniferous granitic rocks in this region, with local equivalents in the form of sills of porphyry. This was accompanied by hydrothermal solutions and vapours, which were injected into the surrounding rocks under great pressure, filling the cavities and replacing much of the adjoining country rock.
4. A second period of earth movement, due to adjustment of the strata to altered conditions, caused normal faulting on two separate occasions, followed by a second deposition of quartz, &c., from hydrothermal solutions.
5. Finally there has been considerable secondary enrichment in places, brought about by circulating waters, probably in part meteoric.

That the Devonian beds in this State were folded during a Pre-Carboniferous period is clearly evidenced by the difference in the amount of folding in each, that in the Devonian strata being much more pronounced.

The possibility of the main Hill End series being of Silurian age does not affect the premise that the Ordovician beds found there had been previously folded; and similar conditions appear to have pertained, whatever the geological age. The fact that compression may cause openings mainly along bedding planes, although not common, is evidenced by the Bendigo (Vic.) occurrences.

There is very little doubt that the Chambers Creek granite exposures are part of the Bathurst Bathylith, both on lithological and geographical evidence, the age of which has been recognised as Post-Devonian; and it is reasonable to assume that the Hill End sills represent phases of the same intrusion.

As already pointed out, it is almost universally recognised that igneous intrusions have played an important part in the formation of reefs and ore deposits. The genetic connection of the Hill End reefs with a granitic intrusion is indicated strongly by the abundance of mica in many of the veins. The evidence of replacement of country rock by vein material is most marked, and is dealt with on page 58.

The second period of earth movement was probably induced by the rocks in this neighbourhood adjusting themselves to the altered conditions arising subsequent to the intrusions. This caused faulting on at least two separate occasions, and was accompanied by the further infiltration of solutions and vapours carrying lode material. It was probably during this period that most of the fissures and cracks, caused by the adjusting of the strata to the altered dynamic conditions, and some of the fault planes, were filled with quartz, &c.

Digitized by Google

The final stage, as represented by secondary enrichment, may possibly be going on to the present day, for the writer has found on other fields in this State (particularly Wyalong) that recent deposits of iron oxide derived from permeating waters, frequently found in old workings, carry appreciable gold contents.

The quartz reefs of the Hill End gold-field may be classified by form as follows:—

1. True bedded veins in rocks of Ordovician age.
2. True bedded veins in the form of normal and inverted saddle reefs in beds of assumed Devonian age.
3. Reefs and "blows" of quartz in the contact zone between the Ordovician and Devonian strata.
4. Small fissure veins, purely local, and often found as spurs or offshoots from the former types.

These will now be reviewed in detail in the order given.

1. True bedded veins in the Ordovician rocks.—As indicated in the early portion of this work (page 34), the number of identical veins of this type is very numerous, but this would certainly be more than doubled if each vein in an individual group were counted, together with all the new veins met with in the deeper workings on the field.

In fact, so close were the veins in some of the upper levels, that it payed to take out and crush whole faces containing fifteen or twenty veins over a width of some 14 feet, each being separated from the other by a narrow parting of country rock. As a rule, individual veins seldom attain to a thickness of a foot, and more often are to be measured in inches; but when the veins actually come into contact, owing to a replacement of the intervening slates by quartz, solid faces of that mineral many feet wide may occur. Associated with these reefs, almost invariably in the vicinity of a series of small faults, or cross-courses, as they are termed, large irregular-shaped masses of quartz are frequently met with. A typical example of these occurs in the vicinity of Beyer's and Holterman's cross-course, and is referred to on page 71.

The length of this blow, as seen in the 100-feet level south from the Government shaft, is about 10 feet, and it extends beyond the walls on either side of the level, but appears to merge into the mica vein at the face, in a series of threads or leaders.

In places these "blows" consist almost entirely of white quartz, with occasional black bandings or irregular-shaped kernels; whilst in others, large and small angular fragments of slate occur, forming a regular breccia. In many cases these occurrences have been proved to contain high gold values, whilst others do not pay to work. Their origin is not quite clear, for whilst they almost invariably occur in the vicinity of faults, thus implying a connection between the two, in the observed cases the quartz appears to merge into the bedded veins, which have been displaced by the faulting, and consequently were of an earlier origin. In the light of the available evidence, however, it would appear that they post-date the bedded veins, and represent infilling and replacement in the vicinity of faults, and have been formed by the deposition of silica from hydrothermal solutions accompanying or subsequent to that phenomena. If this interpretation be correct, it implies two ages of gold deposition, namely, during the formation of the bedded veins, and subsequently to the faulting.

That many of these veins represent both cavity filling and replacement is evidenced in the case of the former by occasional reefs of crystalline quartz,

Digitized by Google

and the latter by black bands of quartz (originally slate) towards the sides of the vein, and parallel to the bedding. In places the slate has not been entirely replaced by silica, and a graduation between the two is noticeable. This is a feature very much in common with the Bendigo reef material, and even when complete replacement is present; the original black nature of the country rock is still observable in the replaced zones.

The most characteristic features of the bedded veins in the Hawkins Hill belt are their narrow width, truly bedded character, and persistent dip. The veins, although individualised by name, as often as not consist of a group of three or more in a well-defined channel. These are spoken of as hanging-wall vein, middle, and footwall vein, depending upon their relative position as regards the walls of the channel. The veins, though generally distinct, often run together by reason of replacement; or it may be that one or more will pinch out for some distance, and between the walls of the channel, only a mere thread of quartz is visible, in addition to the persistent vein. In places the single vein left may be less than half an inch in thickness, or, again, may fill practically the whole width of the channel with quartz separated by thin bands of slate. It is safe to say that few if any of the normal bedded veins are over a foot in thickness, and in the majority of cases much less.

The richest veins, as exposed at the present day, are from a mere thread up to 2 inches in thickness, and this apparently was also characteristic of the earlier workings. This drawback, from a mining point of view, is counteracted by the fact that each vein of the series, together with the associated country rock, often carries values, so that it pays to take out the full width of material in both level or stope, thus giving a working space of from 3 to 4 feet wide. In places, however, even when in a gold chute only one of the veins and practically no country rock carries payable values, thus necessitating the excavation of a considerable thickness of barren rock. The disadvantages of this are, however, considerably minimised by the readiness with which the channel material and auriferous quartz separate from the two defined walls, thus affording cheap mining conditions.

Mention has already been made of the occurrences of a considerable thickness of quartz veins and slate, both payably auriferous, the best example of which appears to have been in the middle workings in Cock and Attwood's claim, where a face 15 feet wide, containing some forty veins with spurs and droppers, payed to take out and crush. The average yield from this was 22 oz. of gold per ton, and that after patches yielding 700 oz. per ton had been picked out.

The plate facing page 52 is an example of this mode of occurrence, although comparatively insignificant when compared with what must have occurred elsewhere. In this instance only a 3-inch vein was showing in the main tunnel, 75 feet further north, yet the face forming the subject of the photograph contains about 6 feet of slate with numerous quartz veins.

In many places throughout the mine workings a marked corrugation in the walls is noticed. These invariably pitch to the north at an angle of from 30 to 40 degrees, and show a width of about 15 inches in the troughs, and from 3 to 6 inches on the ridges.

Similar occurrences were observed in the walls of reefs in the Devonian beds, but they are not so noticeable as in the Ordovician rocks, possibly because the workings available for inspection are limited in extent. In the 220-feet level north from the Exhibition shaft (Reward Mine), an example

Digitized by Google

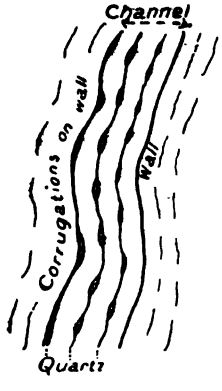
is to be seen; and here they are coarser than in the Ordovician beds, and average about 2 feet across in the trough, and up to 1 foot on the ridges, with a northerly pitch of 34 degrees.

A more diminutive form of corrugations occurs in the Ordovician rocks, particularly adjacent to the Mica vein. A good example of this was seen in a winze being sunk on that vein below the Amalgamated tunnel during 1918, and a face some 10 feet high was exposed, showing the hanging-wall vein in a succession of lenses, connected by a thin thread of reef material. In this instance the maximum width of the vein was 8 inches in the bulges, the minimum being half an inch in the connecting links.

The lenses are from a foot to 15 inches long, and the connections range from 2 to 4 inches in length. The lenticular shape is perpetuated in the bedding planes of the walls for 3 or 4 inches from the vein; and whilst the cleavage is, as a rule, more pronounced than the bedding, the flexures conform to the latter, and in this case the cleavage was less noticeable.

Instances were observed in which the whole channel assumed a more or less wavy dip, with a marked change in the angle of underlay extending over some 10 or 15 feet.

In fact, when reviewing all the evidence, one finds that conditions resembling the following occur in places:—



Another peculiarity noticed in connection with the walls of veins on this field is the presence of an apparent marked striation. This is seen not only in the actual walls of the channel, but extending back for nearly an inch from the wall face, and repeated on almost every bedding plane.

On close examination these are found to consist of innumerable parallel ridges of silica, in places attaining a thickness of nearly one-eighth of an inch. This structure is noticed over faces many feet in area; and in every case the ribbing of quartz pitches south at an angle of 60 degrees from the horizon, with all the striæ absolutely parallel, and less than one-sixteenth of an inch apart. Although not always present when values are good, it is noticeable that when this structure is well marked the gold contents of the lodes are as a rule high.

The casts of the striæ are often impressed upon the vein-filling quartz, thus signifying that they antedate the veins. The structure is not only confined to the Ordovician rocks, and vein material, for many quartz vein fragments from Devonian strata, picked up all over the field, exhibit a cast of similar structure.

These markings have all the appearance of slickenside striations, and the writer is at a loss to account for their presence. The possibility that they may represent shrinkage lines, formed whilst the strata was more or less open, presents itself, thus causing a drainage channel for the silica-saturated solutions, part of which was deposited on the striæ. The above were not observed in replacement zones, nor adjacent to the large irregular makes of quartz.

That at least two ages of quartz deposition took place is strongly evidenced in many of the vein channels, for quartz leaders traversing the bedding planes are seen to be absolutely dissected by the bedded veins (see plate IX).

Digitized by Google

Another instance of this is shown in a section prepared by Mr. A. W. Marshall, and published by the Institute of Mining and Metallurgy, "Hawkins Hill and Hill End, New South Wales," by A. W. Marshall; read before the Institute in London on 17th April, 1901.

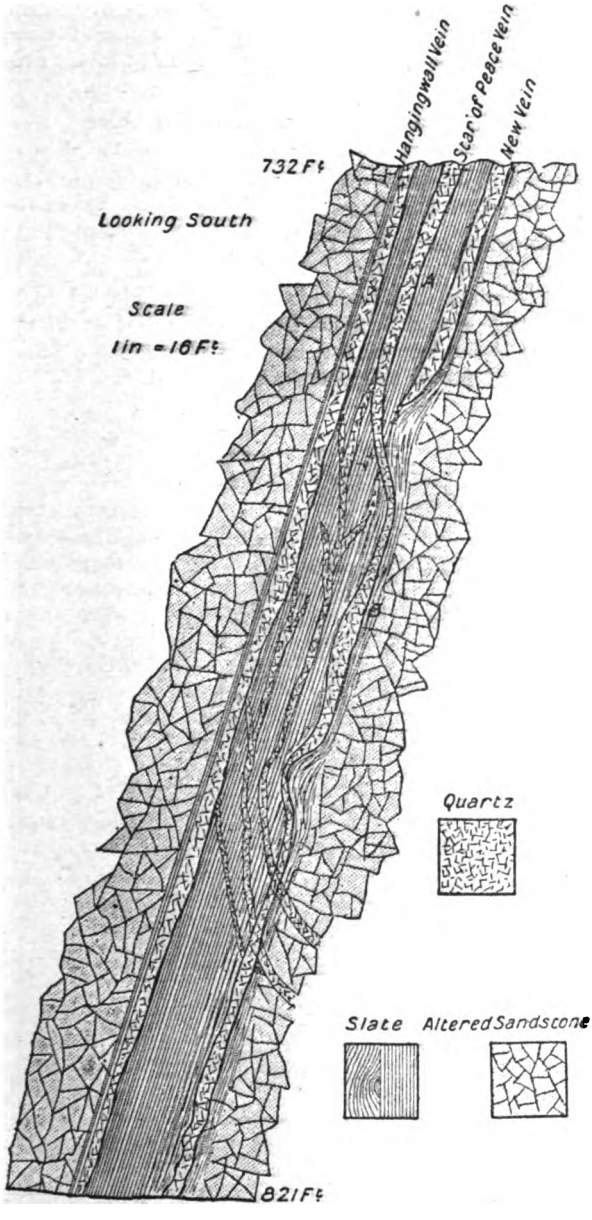


FIG. 2.—Star of Peace and New Veins

Digitized by Google

The foregoing section represents "the south end of the slopes on the last work done in the Star of Peace from 732 to 821 feet levels." The slight flexures in the Star of Peace vein, and the pinching out of the "new vein" (footwall) are very characteristic, whilst the primary fissure fillings are also pronounced. It would appear as if shrinkage cracks had developed in the sedmentary rocks, which were eventually filled with quartz, and subsequently open spaces were formed along the bedding planes, fracturing the previously deposited quartz vins, values in which are practically negligible.

Another interesting occurrence recorded by Mr. A. W. Marshall in the same paper is as follows:—

"A remarkable feature of Paxton's vein at a spot about 200 feet 'deep' is shown in the diagram as under:—

"The vein came on to a flat 'floor' of very hard slate and sandstone. The quartz spread over this 'floor' in masses, and was very rich in gold. One hundred tons taken from this spot yielded 10,000 oz. This 'floor' certainly brought the gold to the vein, but at the same time did not permit it to go deeper; for, in spite of much searching, no payable quartz has been found below it in this vein."

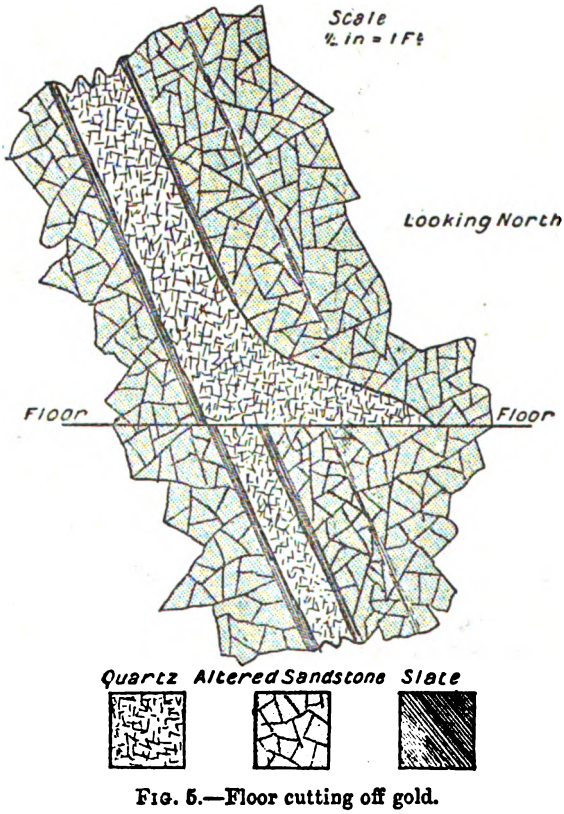


FIG. 5.—Floor cutting off gold.

Digitized by Google

Not having seen this occurrence, the writer is not in a position to comment on it, but the possibility of a flat fault similar to that described on page 71 presents itself.

Although the great bulk of the material forming the veins is silica, in places a pronounced banded structure of quartz and calcite is observed, such being parallel to the walls. Even the gold contents of these veins appears to favour a similar parallelism, for accounts of some of the early finds all agree that the gold, more often than not, occurred thus, sometimes in thin plates many inches square. The calcite is in places pure white, but many instances were observed in which it had a strong resemblance to carbonate of iron, owing to discolouration. If anything, the calcite appears less favourable to the gold contents than the quartz, although many instances were observed where the most pronounced values occurred along the contact of calcite and quartz.

Sulphide of iron, either in the form of pyrites or pyrrhotine (magnetic iron pyrites), the former easily predominating, is the most common metallic mineral contents of the veins; but most of the former appears to have been deposited subsequent to the main vein formation.

In no case are these minerals found to contain an appreciable gold content other than that found as coarse granules, so that concentrating tables are unnecessary in connection with treatment plants. Occasional small crystals of mispickel (arsenical pyrites) occur, as also do zinc blende and galena (sulphide of lead); but here again the gold content is always detectable with the naked eye.

As the name implies, the Mica vein is characterised by the presence of numerous small crystals of muscovite. In fact, in the upper levels this mineral would appear to have constituted a large proportion of the vein filling, but it is not nearly so pronounced in the lower levels.

Yet another peculiarity in many of the makes of quartz is worthy of mention. Some of the quartz has a distinctly pseudomorphous appearance, or has facets corresponding to tabulated crystals of calcite.

The indications are that amorphous quartz was deposited in juxtaposition to calcite crystals, and thereby assumed their crystal facets, and the calcite has been subsequently removed by a leaching-out process. The outside edges of some of the reefs in the Devonian beds present a face covered with small angular pittings, somewhat resembling the wax frames provided as a foundation for bees' honeycomb, but without the same uniformity of design. Here, again, this is thought to represent a pitting after the removal of small crystals of calcite, round which the silica was deposited. Cavities in the quartz vein are occasionally seen, in which the quartz has assumed a pseudo crystalline form round the edges of the cavities, facets projecting into the open spaces, and lying at various angles to the sides and one another. This has the effect of flat tabular crystallinity, but no defined crystalographic form appears to be represented. It is probable that the above also represent an original close proximity of quartz and calcite, the latter having been subsequently dissolved away, leaving only rough casts in silica.

The question of the continuity of the bedded veins in the Ordovician strata, in both length and depth, is all important with regard to the life of the field.

Digitized by Google

At least two of the veins (Star of Peace and Mica) have been followed down almost continuously to a depth of over 700 feet from the surface, and there is every reason to believe that these and other veins will persist to even greater depths.

Reference has been made to the additional veins proved in the Amalgamated tunnel workings, distinct from the higher-level veins; and this has an important bearing on future prospects below that level. The new veins are likely to be more fully developed as they extend downwards, for it is clear that many of them start as a mere thread of quartz, and gradually thicken as followed down.

As evidencing the additional makes of veins in the lower levels of Hawkins Hill, it is interesting to quote from a report by the mine manager of the Star of Peace Gold Mine, published in 1880:—

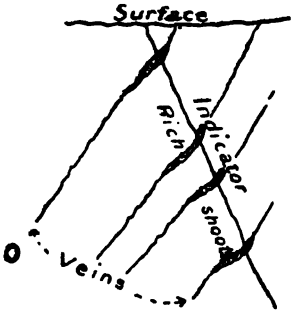
> "There is a crosscut *west* at the 750-feet level for about 40 feet, cutting fourteen veins, some of them showing gold; and as there are only three veins known to be in higher levels, this proves that we have a new county in the bottom."

A similar occurrence was proved in Krohmann's 600-feet vertical shaft.

As regards gold contents, it is apparent, both from the early history of the field, and more recent mining operations, that blanks occur both horizontally and vertically; and there is very little tangible evidence which would help one to locate the payable chutes.

The cross-courses or "indicators" certainly appear to afford the best clue as to a likely place for a bonanza, but although the position of these can be calculated out with a fair degree of accuracy at any level in the leases, the enrichment they produce on contact with the reefs may have taken place in any of the numerous veins, or above or below the level prospected, thus necessitating a considerable amount of dead work.

The following diagram, prepared from information received from old miners on the field, illustrates the conditions as proved in earlier workings.



The height of the rich patches appears to have approximated 80 feet throughout, whilst the length was in the neighbourhood of 2,000 feet. Mr. H. Graham informed the writer that, whilst the chute of gold had a length of 2,000 feet near the surface, it was found to carrot out in depth; and at the bottom of Beyers and Holterman's shaft (about 400 feet) it terminated in an inverted apex.

If a rich chute was struck in an easterly vein or group of veins, then the adjoining claim or vein series on the west carried values about 80 feet below it. The main chute appears to have had a pitch to the north of 1 in 8, but was flat for a short distance about the centre; and here the richest gold values were obtained.

Digitized by Google

Judging from the available evidence, this mode of occurrence pertained right across the series of veins worked, and the bonanzas were found in a zone of "kindly," *i.e.*, somewhat decomposed and highly carboniferous, black slate which came under the influence of cross-courses and droppers or "indicators."

There is a tendency on the gold-field to attribute a persistent northerly pitch to the gold chutes, but the available evidence did not enable the writer to determine whether there is more than one chute. Certainly, from particulars as to the ground stoped during recent years, there does not appear to be the consistency claimed for the earlier gold chutes, and all the more recent gold makes appear to have a southerly pitch of about 20 degrees.

It is claimed by those with early experience on this field that, whilst local occurrences may pitch to the south, the main auriferous chutes pitch north. The writer failed to obtain concrete evidence on the point, but would advise an open mind on the question for the present, and future developments may afford some definite evidence.

As regards the origin of the gold, the writer is of the opinion that it was largely deposited from the solutions given off from the underlying igneous magma basin, and the intrusion of the porphyry sills. Such would leach out gold from the permeated strata, and redeposit it under favourable conditions. That favourable conditions for the precipitation of the gold did not pertain throughout is evidenced by the number of non-auriferous veins and reefs, and the blanks in veins which proved highly auriferous in places. The reefs in Ordovician country, or in contact therewith, have certainly proved more consistently payable than those in Devonian strata, thus indicating more favourable precipitating conditions; and this may be accounted for by the higher percentage of carbon present therein.

In the Devonian strata the reefs are far larger, but the majority of them are practically devoid of gold contents; or when this is present, it occurs in comparatively small and widely disseminated chutes. In no case has the cap of a saddle reef in Devonian strata been worked, and the bulk of the gold won from these reefs has been obtained from eastern dipping legs in the neighbourhood of more or less carbonaceous rocks.

Secondary gold enrichment has undoubtedly played an important part in the bonanzas found in the past; and the writer is of the opinion that percolating meteoric waters played an important part in this enrichment, the facility for percolation being the fault planes, "indicators," and joint faces.

Evidence that these waters dissolved calcite in the upper zones, and redeposited it lower down, is numerous; and, by analogy with other fields, it is reasonable to assume that gold and other minerals were similarly affected. Thus gold from reefs in the Devonian rocks would be liable to be carried down to enrich the veins in the Ordovician beds; and percolating waters would naturally filter along the planes of shattered country, or the line of contact between these two ages of rocks, hence the bonanzas in their vicinity. Under these conditions it is to be expected that the zone of secondary enrichment will die out at a depth, but, as the deepest workings are still some hundreds of feet above the Turon River, which may, to a certain extent, define the limits of circulating meteoric waters, there is still ample depth for the occurrence of further bonanzas.

Digitized by Google

In view of the past experience of the miner on this field, and in the light of the present geological interpretation, the writer is of the opinion that reefs in the Ordovician rocks offer most inducement for future prospecting; and in the absence of any concrete theory as regards the laws governing the occurrence of gold chutes on this field, the writer would advise attention being confined to prospecting in the Ordovician rocks, and considers that particular attention should be paid to faulted zones, belts of reefs affected by "indicators," and the contact zone between Ordovician and Devonian sediments.

The writer suggests that many of the veins worked on Sargent's Hill, but which could only be investigated on the surface, may represent the dying out of the bedded reefs in Ordovician strata, as they pass into the younger rocks.

If this be the case, the prospects of obtaining good values in these reefs, when followed into the older rocks, is decidedly encouraging; and once the water difficulty is solved by the Amalgamated tunnel penetrating for enough north, there should be a big scope for the miner over this area, by sinking to greater depths than was reached in the past.

The Flat Ground.

A rather uncommon geological phenomenon with regard to reef mining is observed on the western slopes of Hawkins' Hill. The bedded reefs and country rock, which have a normal dip of from 65 to 75 degrees to the east, are all found lying almost flat, or in a series of gentle undulations, dipping either to the east or west.

This occurrence extends from near the summit of the hill, down to the neighbourhood of Nuggetty Gully, with a length of fully 20 chains. In the centre the veins were worked into the hill for fully 300 feet, and wonderfully rich returns obtained, before they assumed their true dip. The "formation" is all more or less broken up, and in places consists of both Devonian and Ordovician rocks, with considerable accumulations of clay mixed up with the rock masses.

In other cases fairly large belts of Ordovician strata, with included auriferous quartz veins, occur, all in a more or less horizontal position. As the veins were followed in, wherever persistent, they connect with the various recognised bedded veins, and assume their normal dip (from 65 to 75 degrees to the east), whilst the country is undoubtedly *in situ*.

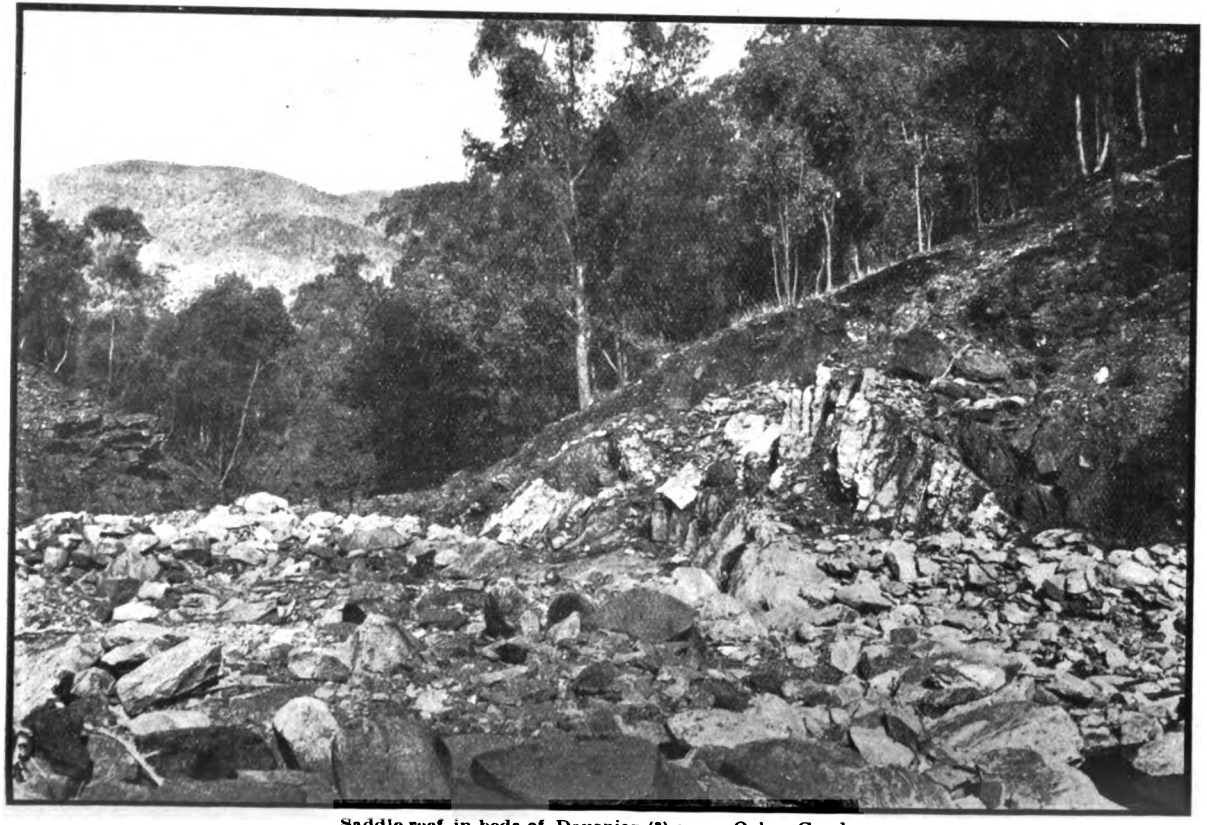
The earlier finds of reef gold on Hawkins Hill were nearly all in the "flat ground," and it is estimated that some hundreds of thousands of pounds worth of gold was obtained from this source.

The hillside has been completely riddled with tunnels and pot-holes, and even at the present day small quantities of payable ore are being won, despite the natural difficulties of working the ground owing to the risk of falls of earth, caused either by the detrital nature of much of the material penetrated, or old mine workings. There is no doubt that this area represents a huge land slide on the south side of the hill, the present slope of which is from 50 to 60 degrees from the horizon. The primary cause may have been the undermining of the black slates along the course of Nuggetty Gully, when, owing to the superincumbent weight of "big" Devonian country near the crest of the hill, a large belt of formation crept over, probably during an exceptionally wet winter.

Digitized by Google

Digitized by Google

PLATE XI.



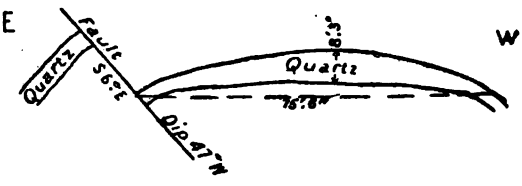
Saddle reef in beds of Devonian (?) age. Oakey Creek.

Digitized by Google

Saddle Reefs in Beds of Assumed Devonian Age.

There is ample evidence that true saddle reefs exist on this field, and that these are confined absolutely to the younger formation (Devonian?). Three or four typical examples will suffice, although there is abundant evidence to indicate that practically all the reefs in beds of that age are in the form of saddles, either normal or inverted.

One of the best examples is seen in the bed of Oakey Creek, a short distance below Nuggetty Gully junction. This is shown in the accompanying plate. The reef has a maximum thickness of 8 feet 3 inches at the apex, and both legs are to be seen dipping respectively to the east at 40 degrees, and to the west at 28 degrees, at a given spot, with a tendency to become thinner as traced down. The eastern leg has been faulted, and this, with other information, is shown in the following diagram:—



There are no appreciable gold values, and the reef consists entirely of massive white quartz.

Plate XI is prepared from a photograph of this occurrence, but a more comprehensive view is obtained with the naked eye; and further down the creek to the left the folding of the overlying sediments can be seen, also the displacement by the fault.

In the bed of Sawpit Gully, a branch of Oaky Creek, some half mile lower down, another well-defined saddle reef is exposed on either bank of the creek.

This occurrence is on the same fold axis, but about 50 feet below the first mentioned, thus proving that the saddles occur one under the other. A short tunnel was driven on the eastern leg, which has a width of 4 feet, but the gold contents were not payable.

A third example is to be seen on the crest of Sargent's Hill, on the road to the Recreation Reserve. It is on the same fold axis, but some 1,200 feet above the occurrence in Oaky Creek, and is not payably auriferous.

Immediately behind the Hill End Post Office another good example of a saddle reef is to be seen, on the eastern anticlinal fold axis. A normal and inverted saddle reef occurs on the eastern side of the Tambaroora-Hargraves road, about half a mile north of the former village.

A good example of an inverted reef may also be seen in a gully running into Oaky Creek, a short distance below the saddle reef first mentioned This occurs between the western syncline and the eastern anticline.

The fact that the fold axes along which the saddle reefs are developed have a well-marked pitch to the north and south causes the bedded reefs to assume either a concave or convex shape over their outcrops; and innumerable examples may be seen of the contour of reefs cropping out along the axes.

The saddle reefs, as a rule, consist of a barren white quartz, but some of them contain both quartz and calcite in bands or blebs, the former lying parallel to the walls, with which are associated sulphides and arsenides.

Digitized by Google

The metallic mineral contents are apparently higher than in the reefs in Ordovician beds, and in some cases magnetic iron and arsenical pyrites, together with zinc blende, galena, and iron pyrites, are very abundant.

A noticeable feature with regard to the bulk of iron pyrites present in all types of reef is that it occurs as thin films like paint on joint faces in the quartz, and not embedded in it. This would seem to indicate that it is of later origin than the bulk of the vein material.

In no case that the writer observed were any gold values present in the immediate vicinity of this form of pyrites. Fragments of coarse gold are frequently to be noticed in the sulphides, but it is always free, and, after passing over the plates, these and the quartz tailings are practically devoid of gold contents.

With regard to the saddle reefs, in every case that the writer was able to either gain reliable information about or examine personally, a tendency to die out at no great depth on both legs was characteristic, or conversely, if the "cap" of an inverted saddle was pronounced, then the ascending arms gradually thinned out.

In a few cases these reefs yielded quite a large amount of gold (particularly at Red Hill and Rowley's reef); but it was always found in comparatively small chutes, with no great depth, and eventually the vein failed to yield payable values, or thinned out entirely.

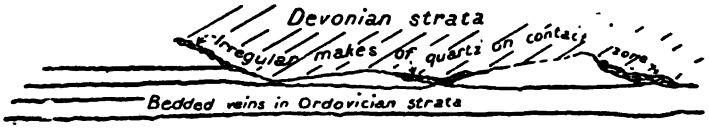
The Red Hill belt of reefs, as far as gold contents are concerned, certainly had considerable length, but the height of the gold chutes was very restricted (see page 46).

The evidence obtained on this field emphasises the writer's past experience with reefs in Devonian strata—that is, they are invariably very patchy as to gold contents, the auriferous chutes being small and sparsely disseminated. Without wishing to be pessimistic with regard to the above, the writer takes this opportunity of suggesting to mining companies the advisability, after working out a proved chute of gold in reefs occurring in beds of this age, of considering the cost of further prospecting, and the financial position of the company, before doing extensive prospecting in search of other chutes.

Reefs and "Blows" of Quartz in the Contact Zone.

Prior to the deposition of the younger sediments on the old Ordovician land surface, the latter had become more or less decomposed.

During earth movements which caused the folding in the Devonian strata, there appears to have been a tendency in places for open spaces to form along the contact, as evidenced by the presence of quartz and calcite crystals. These factors, and the uneven nature of the line of contact, afforded facilities for the percolation of circulating solutions and vapours. Under favourable conditions large irregular makes, or true reefs of quartz were deposited, particularly where a bedded reef in Ordovician strata passed into the contact zone, thus:—



Digitized by Google

The best known example of this mode of occurrence is known as "The Frenchman's". ("blow" or "reef").

In most cases of this type the hanging wall is pronounced, and generally marks the termination of the quartz filling; but the footwall (Ordovician slates and sandstones) is very irregular, and comparatively soft, with veins and blebs of quartz extending into it for some distance. Considerable replacement of the slate by quartz has taken place, and gold occurs on the bedding planes of the "country" as well as in the quartz.

The big occurrences in the 320-feet level south from the Exhibition shaft, previously referred to, are instances of the extent in places of these makes, whilst the quartz reef west of the old 220-feet level in the same mine, and now being worked, and known as Harper's reef, is another example of a more restricted type. These occurrences are liable to be erratic in their strike and dip, such being dependent upon the contour of the ancient land surface; and they may be limited in extent, but reoccur again a few feet further along the contact. An instance of their patchy nature was observed in the Exhibition shaft workings. In the 220-feet level the contact reef has already been proved over a length of several hundred feet south of the main crosscut; but 40 feet north, a crosscut or "rill" has been driven west for 29 feet 6 inches, and passed through the contact with no reef material showing. This crosscut has been holed through to the 320-feet level on the contact, which is to be seen near the face. In the winze, a few feet below the crosscut, a well-defined make of payable quartz was penetrated, with good values. In the crosscut itself, the quartz occurs as veins and irregular shaped masses in the Devonian beds, and the veins are all dipping to the west, a most unusual occurrence, but are devoid of values. This westerly dip brings them back into the contact at a lower depth, as proved in the winze, and gold values are payable.

See Section, p. 50.

Mention has been made of the Robert Emmett, or Emmett and Hughes vein, which had an east and west strike. This is supposed to have been on a fault plane, but the writer could find no evidence in support of a big fault on the surface. The workings are now full of water, and there was no chance of studying the occurrence, but the 320-feet level north from the Exhibition shaft had reached the calculated position of the fault plane, and, whilst there is evidence here of a zone of disturbance, there does not appear to have been any great displacement.

A description of this occurrence obtained from men who worked there does not appear to throw much light upon its character, except that the reef was striking east and west, showing an apparent displacement of from 60 to 80 feet in the north and south veins, but that the veins abutting on it at the western end showed very little, if any, displacement, and that *the footwall was a dark blue slate, whilst the hanging wall was a much coarser rock.* This latter point is important, as it shows a marked analogy to the contact veins; and the writer would not be surprised if such were its origin.

Up to the present the western contact has never been seen underground, whilst the surface exposure is very much masked; but the possibility of the Golden Gully line of reef, which was very rich, occupying that position is important, and shows that highly payable makes of ore may occur there.

As conditions are likely to be similar to those found on the eastern contact, the present companies are advised to pay attention to it by means of

Digitized by Google

crosscuts, and, if conditions appear favourable, to drive along it. Being so irregular, and devoid of vein material in places, the driving may be essential to giving it a thorough test.

Fissure Veins.

This fourth type of vein or reef plays a very minor part in the economic life of the auriferous belts, and in addition to being insignificant in size, are only workable in conjunction with the bedded veins within an auriferous zone, by reason of their irregularity and limited extent. They have no continuity, and are generally thin and devoid of values except for a few feet back from their intersection by the bedded veins. That they are of earlier origin in most cases is evidenced in both the Ordovician and Devonian strata; and many instances were observed in which they were broken and traversed by the bedded veins (see plate IX). Certainly in some cases it is reported by miners and others that gold values were better in the bedded veins when the fissure veins came into contact with them, but no opportunity for an examination of these instances presented itself, so that the writer is not in a position to comment on it.

FAULTING.

The faulting and fractures found in association with the veins may be divided into two groups, namely:—

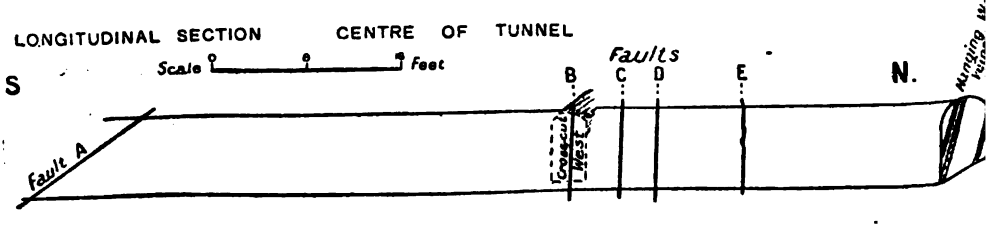
A. True faulting which has caused an actual displacement of the veins.

B. Fracturings without any apparent movement.

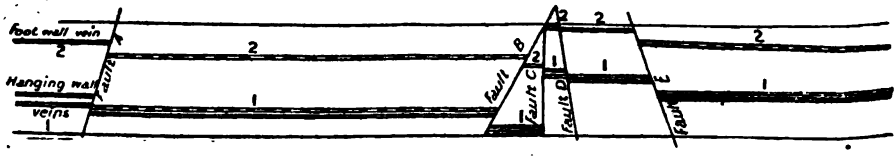
In mine workings five of the former type have been identified, and proved at various levels. These are named as follows, from south to north, and are spoken of as cross-courses:—

1. Beyers and Holterman's.
2. Fisher and Beard's, or Herman's.
3. Mathewson's.
4. Patriarch.
5. Robert Emmett, or Emmett and Hughes'.

All these consist of either a main fault plane, with a number of minor branches, or a series of planes, each causing approximately the same amount of displacement.



PLAN OF ROOF *in above Tunnel Section*



Digitized by Google

Beyers and Holterman's.—Reference to the figure on previous page will enable the reader to follow the characteristics of this zone of shearing, as it may be termed, for no pronounced main faulting has taken place. The figure is to scale, and shows the angles of hade, displacement, &c.

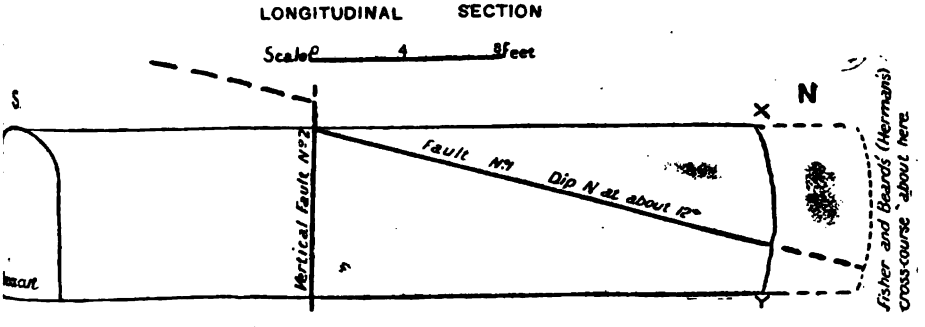
The other occurrences are all very similar to Beyers and Holterman's, but owing to the ground overhead having been stoped out and filled with mullock, or the walls of the drive being timbered up, it was not possible to obtain data for detailed description.

Fisher and Beard's fault appears to have given a horizontal displacement in the veins of about 12 feet, but the evidence as to the amount of throw is very meagre; whilst *Mathewson's* shows a displacement of only 3 feet horizontally.

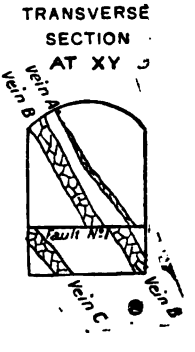
The Patriarch fault has caused a displacement of less than 6 inches, and appears to be vertical; but it was only seen in the bottom level, 500 feet, and owing to these workings having been under water for some years, the exposures were more or less covered with mud.

No examination of the mine workings on the Robert Emmett fault was possible, owing to their being under water, but the information obtained regarding it is given on page 69.

At a later period further faulting took place, the forces expounding themselves in fractures dipping to the north at 12 degrees, and displacing the previous fault planes 3 or 4 inches horizontally.



The best example of this type was seen in a level driven north from the "Stinking Winze" crosscut, or the Star of Peace vein at the Amalgamated tunnel level. The above Figure, drawn to scale, depicts this occurrence.



The strike of the foregoing faults are shown on plan 4.

Evidence of the pressure of strike faults is difficult to obtain, but that they exist is well seen in the prominent saddle reef in Oakey Creek, below the junction of Nuggety Gully (see plate XI. and diagram, p. 67).

Here a fault is to be seen on the east side of the saddle reef in the Devonian rocks, with a strike conforming closely to the strike of the Ordovician strata in that neighbourhood. The vertical displacement of this fault is 4 feet, whilst the strike is N. 6° W., and the apparent hade S. 84 W. at 47 degrees.

Digitized by Google

Other evidences of strike faults are to be seen in the mine workings, and also on the track down the west side of Nuggetty Gully. Their presence is evidenced by highly-polished or striated rock faces conformable to the bedding planes. Other evidences of movement are found in the form of "droppers" or "indicators," as they are termed on the field. These appear to be terms applied to one and the same phenomena, and they occur as fissures with a steep westerly dip, and a northerly pitch. If seen in transverse section they are spoken of as "droppers," or "western breaks," but when cut longitudinally in a drive the term "indicator" is used. They vary somewhat in strike and dip, for whilst some dip S. 45 W. at 63 degrees, others dip in a north-westerly direction underlaying up to 80 degrees.

A further series of fractures or joint faces occur, with a fairly consistent dip of from 30 to 40 degrees to the west, and pitching either north or south at a low angle (up to 20 degrees). These are at varying distances apart down to 3 inches, and are more noticeable adjacent to the veins. In places they contain a thin thread of calcite or quartz, which merges into the vein, thus indicating that they acted as feeders to the main channel. No displacement occurs, and it is probable that they represent a series of joint faces induced during the folding of the beds, which gave rise to the open spaces now occupied by the reefs.

The relation of all the foregoing to the gold contents has been commented on previously (page 64), and it would seem advisable for mine managers and others interested in the field to study them carefully, with a view to obtaining information which might assist in the location of payable chutes of ore.

ALLUVIAL GOLD-MINING.

In the past this area was the scene of probably one of the most important alluvial gold-mining "rushes" in the State. The principal water-courses in the neighbourhood of Hill End and Tambaroora have been worked over and over again in search of the precious metal; and in places, particularly Nuggetty Gully, Oaky Creek, Hill End Creek, Golden Gully, and Tambaroora Creek, phenomenal gold yields were obtained from the shallow alluvial deposits.

After the first rush of European miners had subsided, in the early "seventies," there was a great influx of Chinese, who again went over the ground previously worked. It is estimated that there were some 14,000 Chinese engaged in winning gold throughout the district at one period, and they obtained some hundreds of thousands of ounces of alluvial gold from the areas already supposed to have been worked out.

At the present day there are probably about a dozen fossickers at work in the various gullies, and even yet payable returns are obtained when water is available for sluicing. These men fossick round in the hopes of finding a small patch of virgin ground, and their efforts are occasionally rewarded. The writer saw five nuggets recovered during his visit, the weight of the largest being 18 dwt., and good yields of finer gold are occasionally obtained.

Digitized by Google

It is to be regretted that no record of the alluvial gold won was kept, and it is not possible to form any estimate of the *tonnage* (used advisedly, for the total returns must run into several tons).

Efforts were made of recent years to again work the drifts by means of a gold dredge, but nothing came of the scheme, the question of a permanent water supply probably being the main obstacle.

SUMMARY.

The Hill End-Tambaroora Gold-field was the scene of the first reef mining operations in Australia, and since its discovery, towards the close of 1851, it is estimated that about 50 tons of gold have been recovered from an area of some 5 square miles.

The sedimentary rocks would appear to represent two distinct geological periods, probably referable to the Ordovician and Devonian epochs. At a later period (Post-Devonian), igneous intrusions took place in the neighbourhood, and probably played a most important part in the formation of the auriferous veins and reefs.

The rocks to which the Ordovician age has been assigned consist mainly of dark-coloured, highly-cleaved slates, with which are associated beds of fine-grained sandstones. The younger series (Devonian?), which lie unconformably on the foregoing, are made up of a series of arkose rocks, tuffs, quartzites, and occasional beds of slate, with which are associated contemporaneous lava flows.

The easiest means of distinguishing the rocks of the two geological periods is by the marked occurrence of coarse fragments of felspar in the younger series, and by the presence of a coarse slate breccia along the line of contact.

Three main types of reef were identified, namely, bedded reefs in rocks of Ordovician age, makes of quartz in the form of reefs or "blows" along the contact zone, and true saddle reefs in the younger rocks. Of these three, the first-named are the most numerous, and have probably yielded by far the larger proportion of gold won from the field. The second type is also important as a gold producer, and the miner should realise that it is liable to be very inconsistent in strike and underlay. Moreover, it is not always present, but may be expected to make again in a short distance, but not necessarily on the same line of strike.

The saddle reefs are numerous and large, but, with one or two exceptions, have never been proved to be payably auriferous; and even in the case of the exceptions, the gold chutes were small and widely disseminated.

The reefs in the Ordovician strata and the beds themselves are obscured by a blanket of Devonian rocks over the greater part of the field; and in prospecting along the strike of the main auriferous belt, the overlying rocks would have to be penetrated, and sinking continued to some depth in the Ordovician rocks before cross-cutting in search of bedded reefs. This applies particularly to the northern end of the field. In every case it would be advisable to extend the crosscuts to the contact zone on both sides in

Digitized by Google

search of makes of auriferous quartz. Development work should be carri out in such a manner as to intersect as many veins as possible in t neighbourhood of the cross-courses or faults. There is proof that n bedded veins are developing at a depth, and these should pay to investiga by winzing and cross-cutting below the Amalgamated tunnel level, aga carrying out the work in the vicinity of a cross-course.

The gold occurs in distinct chutes, the richest proved up to the presen having a height of about 80 feet, over a length of 2,000 feet, pitching t the north, and carroting out underfoot. As followed down, the chute ha a tendency to pass to the west into adjoining veins.

More recent work has proved gold chutes with a definite pitch to th south, but enough work has not yet been done to express an opinion as t whether they also pass to the east or west into adjoining veins when followed down. It is suggested that investigations as to this possibility should be borne in mind by the companies concerned.

It is thought that prospects for obtaining further good makes of payable ore are favourable, and if the suggestions made here are first given a thorough trial, prospecting work will be on definite lines, and a considerable saving of useless expenditure effected.

Certainly the gold values are going down, and whilst the multiplicity of reefs entails considerable prospecting work, it at the same time increases the prospects of obtaining bonanzas.

The life of the field is more dependent upon these than the output of a big tonnage of milling ore, and there is always the chance of obtaining thousands of ounces of gold, even though the reef be of insignificant width.

[1 Map 2 Plans; 11 Plates.]

Sydney: William Applegate Gullick, Government Printer.—1918.

Digitized by Google

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES

GEOLOGICAL SURVEY.

J. E. CARNE, F.G.S., Government Geologist.

MINERAL RESOURCES.
No. 28.

BIBLIOGRAPHY

OF THE

ECONOMIC MINERAL

OF

NEW SOUTH WALES.

BY

O. TRICKETT, L.S., M.S.

PART 1.—Particulars of Papers and Reports dealing with Min other than Coal.

PART 2.—Particulars of Papers and Reports dealing with dep of Coal and Kerosene Shale.

Issued by direction of the Honorable J. C. L. Fitzpatrick, M.L.A., Minister for Mines.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER

1919.

[2s. 6d.

† 45901—a

Digitized by Google

Science Library

TN
122
.N421
A3
no. 28

Digitized by Google

New South Wales Geol. Surv. Science Library
ex.
12-10-1923
6-30-24

PREFACE.

One of the most important functions of a State department is to provide information, not only to the existing condition of an industry, but also as to its past history.

The need for the latter condition is particularly evidenced in the mining industry. Many mines which have been actively operated may, through stress of local conditions and mineral prices, become economically unworkable and be of necessity closed down, the records of their yields and of the character of their ore bodies being practically lost in scattered references in official reports.

To obviate this difficulty the "Bibliograph of the Economic Minerals of New South Wales" has been compiled. It has not been the author's intention to compile a complete index to all references to the mining industry of the State, but to confine his endeavours mainly to the reports of Government officials whose information may be regarded as conveying the most accurate data available at the time. In this point the work must be regarded as supplementary to the already published "List of Papers on the Geology of Australia," prepared by R. Etheridge, junr., and R. L. Jack, and issued in the "Mineral Products of New South Wales, 1882," the "List of Papers dealing with the Economic Geology of New South Wales," by W. S. Dun, Vol. VI; "Records of the Geological Survey"; and the "Bibliograyhy of Australian Mineralogy," by C. Anderson, published as "Mineral Resourses, No. 22."

Digitized by Google

Digitized by Google

Alphabetical Index of Minerals and the Localities under which reference is made to them.

Alum. Bullah Delah, Nowra.

Antimony. Aberfoyle River, Abington Creek, Armidale, Barraba, Bellinger River, Bendemeer, Bingara, Bonshaw, Boorolong, Bowra, Bowraville, Bungonia, Cobbadah, Coolongolook, Cudgegong, Dangar's Falls, Dorrigo, Drake, Eden, Gobondery, Golden Gate, Gordonbrook, Gresford, Gulgong, Gundagai, Hargraves, Hargraves' Falls, Hell's Hole, Hillgrove, Inverell, Kempsey, Kookarabooka, Lionsville, Lucknow, Macdonald River, Major's Creek, Manildra, Marulan, Moonan Brook, Mudgee, Munga Creek, Nambucca, Nerriga, Niangala, Nundle, Oberon, Orange, Pyramul Creek, Rivertree, Sofala, Taylor's Arm, Tenterfield, Tuena, Ulmarra, Ungarie, Uralla, Vegetable Creek, Wagga Wagga, Walcha, Wallerawang, Warialda, Willawarrin, William's River, Windeyer, Yarrowyck, Yass.

Arsenic. Ashford, Bathurst, Beechwood, Bingara, Boorowa, Delungra, Ettrema Creek, Glen Innes, Howell, Kookarabooka, Macleay River, Macquarie Port, Marulan, Moruya, Nambucca, Reid's Flat, Tingha, Tumut, Tungsten, Valla, Vegetable Creek, Uralla, Victoria Mount, Wauchope, Wellingrove.

For Assay, see 17/174.

Artesian Water 12/174.

Asbestos. Arramagong, Barraba, Bingara, Blayney, Broken Hill, Gundagai, Oberon, Porter's Retreat, Rockley, Tumbarumba.

Ballast for North Coast Railway. J.E.C. 15/173.

Barytes. Bateman's Bay, Belubula River, Bermagui, Bethungra, Blanket Flat, Boyd River, Braidwood, Broadalbane, Candelo, Captain's Flat, Cargo, Cathcart, Cooma, Crookwell, Dalgety, Dripstone, Gulgong, Major's Creek, Junee, Kerr, Lue, Mandurama, Molong, Mudgee, Pambula, Rockley, Rylstone, Towamba, Trunkey, Tuena, Tumut, Woodstock.

Bismuth. Addong, Ardlethan, Ashford, Atturga, Bega, Bombala, Broken Hill, Captain's Flat, Cobar, Deepwater, Delungra, Fifield, Glen Innes, Grose River, Gundaroo, Guyra, Hillgrove, Holbrook, Hope Mount, Kingsgate, Kookarabooka, Lionsville, Manildra, Markdale, Molong, Murrumbateman, Nimmitabel, Noorooma, Oberon, Orange, Oxley Mount, Pambula, Pheasant Creek, Snowball Creek, Sunny Corner, Tenterfield, Tingha, Torrington, Uralla, Vegetable Creek, Wee Jasper, Wyangle burg, Yass.

For Assay, see 17/174.

Digitized by Google

Building Stone. Sydney, 02/122.

Caves. Abercrombie, Ashford, Bendithera, Belubula, Big Hole, Borenore, Bungonia, Cavan, Cave Flat, Colong, Cooleman, Cudgegong, Fernbrook, Goodravale, Isis River, Jenolan, Jerrara, Kempsey, Kybean, Marulan, Narrangullen, Rosebrook, Stuart Town, Tamworth, Tuglow, Wellington, Wombeyan, Wyanbene, Yarrangobilly, Yessabah.

Chromite. Armidale, Attunga, Barraba, Bimbi, Bingara, Brawlin, Coolac, Cootamundra, Gobarralong, Goobarragandra, Gordonbrook, Grenfell, Gundagai, Gundamulda Creek, Harden, Jindalee, Junee, Macdonald River, Macquarie Port, Manilla, Molong, Moonbi, Muttama, Nundle, Pigna Barney River, Stony Batter, Stuart Town, Tamworth, Taree, Thuddungra, Tingha, Tumut, Wagga Wagga, Walcha, Wallendbeen, Warialda, Wingham, Woolbrook, Young.

For Assay, see 17/174.

Clays, Kaolin, &c. Barraba, Baw Baw, Blayney, Bulladelah, Clarence Siding, Cooma, Corrimal, Dunedoo, Goulburn, Gulgong, Harden, Kelso, Lithgow, Manly, Molong, Murwillumbah, Narrabeen, Nethercote, Newport, Pambula, Parkes, Piddington Mount, Sydney District, Teralba, Towrang, Ulladulla, Vegetable Creek, Whipstick, Wilga Grove.

For Assay, see 17/178. J.E.C., 15/174.

Cobalt. Bingara, Broken Hill, Bungonia, Captain's Flat, Carcoar, Junee, Kempsey, Macquarie Port, Moruya, Murrumbateman, Oberon, Tarago, Toogong, Torrington, Tumbarumba, Windeyer,

Copper. Aberfoyle River, Adaminaby, Arrowsmith Mount, Ashford, Attunga, Badjerrigarn, Bangadilly, Barraba, Barrier Range, Bateman's Bay, Bathurst, Belara, Belubula River, Berridale, Binalong, Binda, Bingara, Black Mountain R.S., Blayney, Bobadah, Bodangora, Bogong Mountains, Bolivia, Bombala, Bonshaw, Bookham, Boonoo Boonoo, Boorolong, Boorowa, Bourke, Bowning, Braidwood, Breadalbane, Bredbo, Brogo, Broken Hill, Bullio, Bumberry, Bundarra, Bungiebomar, Bungendore, Bungonia, Burraga, Byng, Bywong, Cadia, Camelback Mountain, Canbelego, Cangai, Canoblas, Capertee, Captain's Flat, Carcoar, Cargo, Casino, Cell's Creek, Chandler River, Cobar, Collector, Condobolin, Conjola, Congwarra, Cooma, Cootamundra, Copeland, Companhurst, Coppabella, Coramba, Corang River, Coree Mount, Cowra, Cudal, Cudgegong, Cumnock, Currandidgee, Currickabark, Dalgety, Deepwater, Delaney's Dyke, Delegate, Delungra, Doradilla, Drake, Dunedoo, Eden, Ettrema Creek, Eugowra, Euriowie, Felled Timber Creek, Fifield, Forest Reefs, Gilgunnia, Girilambone, Glasson's Paddock, Glen Elgin, Glen Innes, Glen Lyon, Gnalta Creek, Gobondery Range, Gordonbrook, Goulburn, Grenfell, Gulf Creek, Gulgong, Gundagai, Gunnedah, Gunning, Gunningbland, Guy Fawkes, Guyra, Hall, Hampton, Hasting's River, Hermidale, Hillgrove, Holbrook, Hope Mount, Horseshoe Bend, Howell,

Digitized by Google

Jasper Peak, Jenolan, Jindabyne, Jugiong, Junee, Kangaroo River, Kookarabooka, Kooningberry Range, Lewis Ponds, Lindsay Mount, Lionsville, Locksley, Lowther, Macleay River, Macquarie Port, Major's Creek, Mandurama, Manildra, Mann River, Marulan, McDonald Mount, McLaughlin River, Meryula, Molong, Monga, Mongarlowe, Mootwingee, Mudgee, Mulloon Creek, Mullumbimby, Mumble Creek, Murrumbidgee River, Narrabri, Nowendoc, Nundle, Nuntherungie, Nymagee, Oberon, Ophir, Orange, Parkes, Peak Hill, Purnamoota, Queanbeyan, Ravine, Restdown, Rivertree, Rockley, Shellharbour, Sofala, Stuart Town, Styx River, Sunny Corner, Tabulam, Talbingo, Tamworth, Tarago, Taralga, Tarana, Thakaringa, Timberlight Creek, Tindary, Tingha, Toogong, Tottenham, Touga, Trooper's Mount, Trundle, Trunkey, Tuena, Tuglow, Tumbarumba, Tumut, Umaralla, Vegetable Creek, Victoria Mount, Wagga Wagga, Walcha, Warialda, Warning Mount, Wauchope, Wellington, Wilga Downs, Willi Willi, Wonnaminta Station, Woodstock, Woolgarlo, Wymah, Yalgogrin, Yalwal, Yambulla, Yarrangobilly, Yarrolumla, Yass, Yeoval, Yetholme, Yuba.

Diamonds. Abercrombie River, Bendemeer, Bingara, Blayney, Bullawa Creek, Bywong, Colinton, Collas Hill, Copeton, Delungra, Dunedoo, Euriowie, Goulburn, Gulgong, Hill End, Howell, Inverell, Lachlan River, Macquarie River, McDonald Mt., Mittagong, Muckerwa Creek, Nandewar Range Pyramul Creek, Snodgrass, Stuart Town, Tingha, Trunkey, Turon River, Uralla, Werong Mt.

Emery. Nundle.

Fireclay. Ashford, Awaba, Batesman Bay, Bathurst, Black Mountain, Dunedoo, Hurstville, Lithgow, Manly, Marangaroo, Mogo, Molong, Myall River, Newport, Port Stephens, Teralba, Whipstick, Wingello.

Felspar. Bellingen, Hartley Vale, Kootingal, Nambucca.
For Assay, see 17/177,178.

Flourspar. Coppabella, Dalgety, Jingellic, Gulf near Emmaville, Woolgarlo.

Fuller's Earth. Bogabri, Narrabri, Wingen

Natural Gas. Narrabeen, Pyrmont, Ravine.

Gems—Sapphires, Turquoise, Zircons, Beryl, Emeralds. Bingara, Bodalla, Bombala, Bullaboola Mt., Bunbejong, Dunedoo, Inverell, Kiandra, Kookarabooka, Macquarie River, Mittagong, Noorooma, Nundle, Oberon, Ophir, Tingha, Uralla, Vegetable Creek, Warrumbungles; Werong Mt., Wingecarribee River.

Gold. Abercrombie River, Adelong, Albury, Alectown, Araluen, Ardlethan, Armidale, Attunga, Aubrey Mt., Badjer Brush, Ballina, Barmedman, Barraba, Barrington, Bateman's Bay, Bathurst, Batlow, Beach Sands, Bearbong Run, Bega, Belara, Bellinger River, Belubula River, Ben Bullen, Bendemeer, Berlang, Bermaguee, Billabong Goldfield, Billy's Look Out, Bimberamala Creek, Bimbi, Binalong, Binda, Bingara, Black Mountain R.S., Blakeneys

Digitized by Google

Creek, Blayney, Blicks Creek, Bobadah, Bobbiwa, Bobo River, Bodangora, Bog, Bogong, Bolivia, Bolowra, Bombala, Bonley Goldfield, Boonoo Boonoo, Boorook, Boorowa, Bootheragandra, Bora Creek, Boro, Bourke, Boyd River, Braidwood, Branga Park, Breadalbane, Bredbo, Brindabella, Brogo, Broken Hill, Broman, Brown's Camp, Bruisers Creek, Buckle Mt., Bulga Swamp, Bulgandry, Bullah Delah, Bullawa Creek, Bullio, Bundanoon, Bungambrawatha, Bungendore, Bungonia, Burraga, Bye Rock, Byng, Bywong, Cadia, Canbelego, Cangai, Canoblas, Canowindra, Capertee, Captain's Flat, Carabost, Caragabal River, Carcoar, Cargo, Carlisle, Carrai, Cathcart, Cawker's Well, Cedar Log, Cells Creek, Chambigne, Chance Creek, Chandler River, Cheshire Creek, Clear Creek, Cobar, Cobark, Cobbadah, Cobborah, Coco Creek and Range, Colinton, Collector, Colo River, Condobolin, Cooleman, Coolongolook, Cooma, Coonabarabran, Cootamundra, Copeland, Coppabella, Coramba, Corang River, Coree Mt., Coronga Peak, Corowa, Cowabbie, Cowarral, Cowra, Cudal, Cudgegong, Cudgellico, Cugong, Cunglebung, Curragh, Currajong, Currangurra, Currickabark, Dalgety, Dalmorton, Dargall's Creek, Delaney's Dyke, Delegate, Delungra, Denman, Deua River, Digman's Tank, Doradilla, Dorrigo, Doubleduke, Drake, Drysdale Mt., Dubbo, Dun Dun Creek, Dunedoo, Dungog, Eden, Ellenborough, Euabalong, Euchareena, Eugowra, Fell Timber Creek, Fifield, Fish River, Fitzgerald Valley, Five Bull, Forbes, The Forest, Forest Reefs, Four Mile Creek, Frederick's Valley Creek, Frenchman's Creek, Godara, Galambine, Gilgunnia, Ginkin, Ginninderra, Girilambone, Glasson's Paddock, Glen Elgin, Glen Innes, Glenken, Glen Morrison, Goobarragandra, Goodey Creek, Good Good, Goodradigbee, Goonigal, Goonoo Goonoo, Gordonbrook, Goulburn, Grafton, Grenfell, Grey Mares Bogong, Grong Grong, Gulgong, Gundagai, Gunderbooka, Gunnedah, Gunning, Guyra, Hall, Harden, Hargraves, Hartley, Hastings River, Hermidale, Hillas Creek, Hill End, Hillgrove, Holbrook, Hookanville Creek, Hope Mt., Horse Shoe Bend, Horton's Creek, Illalong, Inverell, Iron Pot Creek, Jacob's Swamp, Jindabyne, Jingellic, Junee, Kandie Peak, Kanowie Peak, Kerrigundah, Kiandra, Kiwarrie, Kookarabooka, Koorowatha, Kownung River, Kybean, Lake George, Leaning Oak Creek, Lewis Ponds, Limekilns, Limestone Creek, Lionsville, Little Bog, Little Plains River, Locksley, Lyndhurst, Macdonald River, Macleay Heads, Macquarie Port and River, Major's Creek, Manara Mt., Mandurama, Manildra, Mann River, Marengo, Markdale, Marulan, McDonald Mt., McLachlan River, Michelago, Milparinka, Mittagong, Mitta Mitta, Molong, Monara, Monia Gap, Mongarlowe, Monkerai, Mookalimbira Mt., Moonan Brook and Flat, Moonbi, Moonboy Reefs, Moruya, Muckerwa Creek, Mudgee, Mulgowrie, Mullion, Mullumbimby, Mumble Creek, Mundooran, Murramarang, Murrumbateman, Murwillumbah, Muttama, Myall Lake, Nadgee, Nambucca, Narrabri, Narrandera, Narromine, Nelbothery Range, Nepean River, Nerriga, Newbridge, Newton Boyd, Niangala, Nimmitabel, Noorooma, Nowendoc, Nundle, Nuntherungie, Nymagee, Oallen, Oberon, O'Connell, Ophir, Orange, Palmer's Oaky, Pambula,

Digitized by Google

Panuara Rivulet, Parkes, Peak Hill, Peter's Grass, Pigeon House Mt., Piper's Creek, Pooncarrie, Portland, Pulletop, Purnamoota, Pyramul, Quart Pot Creek, Queanbeyan, Queen's Pinch, Ravine, Restdown, Richmond River, Rivertree, Rockley, Round Hill, Rylstone, Sam's Mount, Sandy Creek, Scone, Scrubby Rush, Sea View Mt., Sebastopol, Shellharbour, Shoalhaven River, Shooter's Hill, Slaughter House Creek, Snodgrass, Snowball Creek, Snowy River, Sofala, Spring Range, Stockyard Creek, Stuart Town, Sunny Corner, Swamp Oak, Sydney Harbour, Tamworth, Tarago, Tarcutta, Taree, Tattlan Scrub, Temora, Tenterfield, Termeil, Tibooburra, Timberlight Creek, Timbarra, Tindary, Tocumwal, Toogong, Tooloom, Tottenham, Touga, Towamba River, Trundle, Trunkey, Tuena, Tuglow, Tumbarumba, Tumut, Turon River, Tuross River, Twill Creek, Tyringham, Umby Creek, Ulmarra, Umaralla, Ungarie, Unngala Creek, Uralla, Urana, Vale of Clwydd, Vegetable Creek, Wagga Wagga, Walcha, Wallace Town, Wallaga Lake, Wallangra, Wallendbeen, Wamboyne, Wangat, Wantabadgery Station, Warialda, Warraderry Range, Wattle Flat, Wauchope, Wee Jasper, Weldragang, Wellington, Werong Mt., Wilcannia, Wilga Downs, Wilson's Downfall, Windeyer, Wingello, Wollondilly, Wolumla, Woodburn, Woodstock, Woogoolga, Wyalong, Yagobie, Yalgogrin, Yallock Run, Yalwal, Yambulla, Yancowinna Creek, Yarrowyck, Yass, Yeoval, Yerranderie, Yetholme, Young.

Gypsum. Balranald, Banoona Swamp, Broken Hill, Culgoa, Ivanhoe, Mullamuddy, Murrumbidgee Irrigation Area, Paroo River, Trangie, White Cliffs, Yantabulla.

Iron Ores. Adelong, Armidale, Attunga, Barber's Creek, Barraba, Bathurst, Bell, Belltrees, Belubula River, Berrima, Binalong (hematite), Bingara, Blayney, Bogabri, Bolivia, Bookham, Boro, Bowenfels, Broadalbane, Brojer's Creek, Broken Hill, Bulli, Bullio, Bungonia, Cadia, Capertee, Carcoar, Carwary, Chichester River, Clandulla, Clarence Mount, Clarence Town, Clear Creek, Coff's Harbour, Colinton (hematite), Condobolin, Congwarra, Cooma (hematite), Copmanhurst, Corona, Cowra, Crookwell, Cudgegong, Curlewis, Dripstone, Dubbo, Dunedoo, East Maitland, Edgecombe Mount, Eskbank, Fifield, Forest Reefs, Geurie, Gibbergunyah Creek, Girilambone, Gobondery, Gordonbrook, Gosford, Goulburn, Gulf Creek, Gulgong, Gundagai, Hall's Creek, Harden, Hermidale, Hexham, Hope Mount, Ilford, Jasper Peak, Jervis Bay, Jugiong, Keira Mount, Kiama, Koorawatha, Lachlan River, Lionsville, Lithgow, Lue, Macquarie Port, Maitland, Mandurama, Manildra, Manly, Marulan, Mittagong, Molong, Moruya, Mount Hope (hematite), Mudgee, Muswellbrook, Muttama, Narrabri (oxide), Narromine, Nattai, Newbridge, Newcastle, Oberon, Orange, Oxley Mount, Parkes, Picton, Pooncarie, Portland, Port Hacking, Port Macquarie, Port Stephens, Queanbeyan, Ravensworth (limonite), Rivertree, Rix's Creek, Robertson, Rockley, Rydal, Seaham, Stockinbingal, Stroud, Stuart Town, Talbragar, Tamworth, Tarago, Taralga, Tingha (pisolitic), Tottenham, Tuena, Tumut, Turrawan (hematite), Vegetable Creek

Digitized by Google

(laterite, bauxite), Wallendbeen, Wallerawang, Waterfall Station (bauxite), Wellington, Westbrook Creek (limonite), Wheogo, Willeroo, Wingello (bauxite), Wingen, Wongarbon (hematite), Woodstock, Woolgoolga, Woy Woy, Yass.

Lead, Galena. Barmedman, Binalong, Black Mountain R.S., Bobadah, Bodangora, Boorowa, Bowra, Broken Hill, Bungonia, Cobar, Colinton, Condobolin, Dalgety, Delegate, Dunedoo, Ettrema Creek, Glen Lyon, Grose River, Gundagai, Hastings River, Howell, Jingellic, Mann River, Nuntherungie, Orange, Pap's Creek, Queanbeyan, Rivertree, Shellharbour, Sunny Corner, Tarago, Tingha, Umaralla, Vegetable Creek, Wellingrove, Werong Mount, Woolgarlo, Yass, Yerranderie.

Limestone. Aberfoyle River, Alectown, Ashford, Attunga, Barigan Barraba, Bathurst, Batlow, Belubula River, Ben Bullen, Bendithera, Bethungra, Binalong, Bingara, Blayney, Bodangora, Bombala, Boorowa, Boro, Braidwood, Breadalbane, Bredbo, Brogan's Creek, Broken Hill, Bullahdelah, Bungendore, Bungonia, Burragorang, Calula, Canbelego, Canberra, Cangai, Canoblas, Capertee, Captain's Flat, Cargelligo, Cargo, Cartwright's Creek, Clarence Town, Cobar, Cobbadah, Colinton, Collector, Colong, Condobolin, Congwarra, Coolac, Cooleman, Cooma, Copeland, Copmanhurst, Corona, Cowra, Cudal, Cudgegong, Cumnock, Delegate, Douglas Park, Drake, Dunedoo, Dungog, Euriowie, Fifield, Forbes, Gerogery, Glen Innes, Gloucester, Goodradigbee Creek, Gordonbrook, Goulburn, Grenfell, Gresford, Gulgong, Gundagai, Hastings River, Hill End, Indi River, Jenolan, Jugiong, Junee, Katoomba, Kempsey, Kowmung River, Kybean, Lewis Ponds, Liddell, Lime Kilns, Macleay River, Macqueen, Maitland, Mandurama, Manilla, Marulan, Michelago, Mittagong, Molong, Moonbi, Mudgee, Murrumbidgee Irrigation Area, Murrurundi, Muswellbrook, Myall Lake, Nimmitabel, Nundle, Nymagee, Oberon, Orange, Parkes, Peak Hill, Picton, Pokolbin (concretionary), Portland, Port Stephens, Purnamoota, Queanbeyan, Quirindi, Ravine, Restdown, Rockley, Rydal, Rylstone, Scone, Sofala, Somerton, Spicer's Creek, Stroud, Stuart Town, Sunny Corner, Talbingo, Tamworth, Taralga, Taree, Tenterfield, Tingha, Toogong, Torrington, Trunkey, Tuena, Tumut, Vegetable Creek, Wallerawang, Walbrobrook, Warialda, Wauchope, Wellington, Willi Willi, Wingello, Wingham, Wollondilly River, Wombeyan Caves, Wyanbene, Yalwal, Yarrangobilly, Yass, Yetholme, Young.

Magnesite. Attunga, Bingara (Upper), Condobolin, Congwarra, Dripstone, Dunedoo, Fifield, Humula, Mount George Station, Junee, Piedmont, Wallendbeen, Warialda, Wellington.

For Assay, see 17/180.

Manganese. Armidale, Barraba, Bathurst, Bendemeer, Blayney, Bonshaw, Bookham, Boro, Bowning, Bungendore, Bungonia, Calula, Capertee, Coffs Harbour, Condobolin, Cookamidgera, Cootamundra, Coppabella, Corowa, Cow Flat, Cudgegong, Cullinga, Danglemah, Dungog, Ellenborough, Essington, Eugowra, Forbes, Grenfell, Gulgong, Gundagai, Hargraves, Hastings River, Kempsey,

Digitized by Google

Kiandra, Macquarie Port, Michelago, Moonbi, Mudgee, Mullumbimby, Murwillumbah, Newton Boyd, Nymboida River, Oberon, Orange, Parkes, Peak Hill, Rockley, Tarago, Tarana, Trunkey, Tumbarumba, Uralla, Vegetable Creek, Wagga Wagga, Walcha, Wingham, Woodstock, Yass.

For Assay, see 17/175.

Marble. Attunga, Borenore, Bowan Park, Briar Park, Bringellet, Bungonia, Caleula, Caloola, Coolalie, Cow Flat, Cudal, Cudgegong, Fernbrook, Kempsey, Limekilns, Longreach, Macleay River, Marulan, Michelago, Molong, Moonbi, Mudgee, Nemingha, Oberon, Parkes, Ponsonby, Rockley, Rylstone, Wallerawang, Waldegrave, Warialda, Windellama, Wombeyan Caves.

Mercury. Barmedman, Barraba, Bingara, Broken Hill, Carrol Creek, Coffs Harbour, Cudgegong, Drake, Dungog, Gordonbrook, Lionsville, Muckerwa Creek, Mudgee, Scone, Sunny Corner, Tenterfield, Trunkey, Windeyer, Woogoolga.

Mineral Waters. Blayney, Bungonia, Cooma, Dubbo, Mittagong, Picton.

Molybdenite. Ardlethan, Attunga, Baldry, Bega, Bolivia, Boorolong, Botobolar, Bundarra, Capertee, Carcoar, Carrai, Cathcart, Cheviot Station, Cootamundra, Deepwater, Delegate, Glen Elgin, Glen Innes, Goulburn, Gulgong, Holbrook, Inverell, Jasper Peak, Kempsey, Kiandra, Kingsgate, Kookarabooka, Kootingal, Krawarree, Lowther, Manildra, Marsden's Swamp (near Hampton), Mitchell, Moonbi, Nambucca, Nymagee, Orange, Pambula, Pheasant Creek, Rydal, Tarana, Tenterfield, Timbarra, Tingha, Valley (The), Vegetable Creek, Warrell Creek, Wilson's Downfall, Wyndham, Yeoval, Yetholme.

For Assay, see 17/175.

Nickel. Adelong, Bathurst, Bingara, Broken Hill, Cooma, Hillgrove, Weares Creek.

Opal. Attunga, Ballina, Bidura, Coonabarabran, Dubbo, Hargraves, McDonald Mt., Purnanga, Trunkey, Wallangulla, Warrumbungles, Wellington, White Cliffs, Wyalong.

Ornamental Stone (see Marbles). Rylstone (nepheline ægirine rock).

Palladium. Broken Hill.

Phosphates. Ashford, Canowindra, Carcoar, Cargo, Molong, Stuart Town, Wellington.

For Assays, see Annual Report, 17/176.

Pigments, Ochres. Araluen, Binalong, Blayney, Bowraville, Brocklehurst, Caleula, Dripstone, Dubbo, Hastings River, Macquarie Port, Manilla, Marsfield, Marulan, Moruya, Mudgee, Newbridge, Shellharbour, Tarana, Wallendbeen, Webb's Creek, Wellington, Wingello, Woy Woy.

See Annual Report for Assays, 17/176.

Digitized by Google

Platinum. Aberfoyle River, Ballina, Beach Sands, Broken Hill, Condobolin, Dubbo, Fifield, Grafton, Macquarie River, Narromine, Ophir, Pambula, Richmond River, Turon, Woodburn.

Plumbago Graphite. Cells Creek, Cordeaux River, Drake, Eden, Pambula, Tingha, Undercliff, Wagga Wagga, Walcha.

Quartzite (see Silica).

Road Metal. Bumbo, Kiama, Minumurra, Paterson River, Pennant Hills, Port Stephens, Prospect, Tweed River.
See 16/211.

Salt. Ællalong.

Sandstone for Building. Maroubra, Randwick.

Sandstone for Abrasive Purposes. M.M., 18/161.

Silica for Firebricks, &c. Bowenfels, Cookbundoon, Marrangaroo, Milton, Ulladulla.

Silver. Aberfoyle River, Abington Creek, Adelong, Albury, Armidale, Ashford, Attunga, Barmedman, Barraba, Bathurst, Beach Sands, Bega, Belara, Bendithera, Binalong, Binda, Bingara, Black Mountain R.S., Bobbadah, Bodangora, Bolivia, Boonoo Boonoo, Boorook, Boorowa, Boro, Braidwood, Breadalbane, Bredbo, Broken Hill, Bullio, Bungonia, Burraga, Byadbo, Byng, Bywong, Candelo, Cangai, Canoblas, Capertee, Chandler River, Clarevaux, Clear Creek, Cobar, Colinton, Condobolin, Congwarra, Cooleman, Cooma, Cootamundra, Coppabella, Coree Mount, Corona, Crookwell, Cudgegong, Currickabark, Dalgety, Deepwater, Delaney's Dyke, Drake, Drysdale Mount, Dunedoo, Dungog, Ettrema Creek, Euchareena, Eugowra, Fifield, Five Bull, Glen Elgin, Glen Innes, Glen Lyon, Gordonbrook, Goulburn, Grenfell, Gundagai, Gunnedah, Gunning, Guy Fawkes, Harden, Hastings River, Hermidale, Hillgrove, Hope Mount, Howell, Inverell, Jingellic, Junee, Kallara Station, Kangaroo River, Kempsey, Kookarabooka, Kooningberry Range, Kybean, Lewis Ponds, Lionsville, Locksley, Lowther, Macleay Heads and River, Macquarie Port, Major's Creek, Manildra, Mann River, Marulan, Michelago, Molong, Moruya, Mudgee, Mullion, Mulloon Creek, Mullumbimby, Mumble Creek, Murrumbateman, Murrurundi, Murwillumbah, Nambucca, Nimmitabel, Nundle, Nuntherungie, Oberon, Ophir, Orange, Paddy's Peak, Page River, Palmer's Oakey, Pambula, Pap's Creek, Pooncarrie, Purnamoota, Queanbeyan, Ravine, Restdown, Rivertree, Rockley, Rydal, Scone, Sunny Corner, Tarago, Taralga, Tarana, Tenterfield, Thackaringa, Tindary, Tingha, Tottenham, Touga, Towamba, Troopers' Mount, Trundle, Tuena, Tumut, Ulmarra, Umaralla, Ungarie, Vegetable Creek, Wagga Wagga, Walcha, Wallagoot, Wean Creek, Wellingrove, Werong Mount, Williams River, Willi Willi, Wingen, Wolumla, Woolgarlo, Wyalong, Wyanbene, Yalwal, Yambulla, Yarrowyck, Yass, Yerranderie.

Slate. Chatsbury, Gundagai, Marulan, Millah Murrah, Molong, Mudgee, Pambula, Taylor's Arm, Wagga Wagga, Walcha.

Digitized by Google

Sulphur. Apsley, Mandurama, Orange, Leadville.
See Annual Report for Assays, 17/176.

Talc—Steatite, Soapstone. Cow Flat, Wallendbeen, Murrumburrah.

Tellurides. Gulgong (gold), Gundagai (gold and bismuth), Oberon (bismuth), Tamworth (bismuth), Uralla (bismuth).

Tin. Adaminaby, Albury, Ardlethan, Attunga, Badjerrigarn, Ballina, Barmedman, Barraba, Basin Creek, Beach Sands, Beechwood, Bega, Bendemeer, Bingara, Bolivia, Bombala, Boonoo Boonoo, Boorolong, Boro, Brassington, Bundarra, Bungendore, Bungonia, Bygoo, Cangai, Carrai, Carroll's Creek, Cathcart, Commissioners' Creek, Condobolin, Copeton, Coppabella, Corona, Dalgety, Deepwater, Delegate, Delungra, Dubbo, Dulah, Eremeran, Euabalong, Euriowie, Felton's Creek, Fifield, Gibraltar, Glendon, Glen Elgin, Glen Innes, Gobondery, Grafton, Grenfell, Grey Mare's Tail, Grong Grong, Gulgong, Gundle, Guy Fawkes, Guyra, Hamilton River, Hastings River, Hillgrove, Holbrook, Howell, Inverell, Jacob's Swamp, Jerrawangala, Jindabyne, Jingellic, Kempsey, Kingsgate, Kolkilberton, Kookarabooka, Kosciusko, Lake Mount, Lowry Creek, Macleay River, Mandamah, Manildra, Marulan, Murrurundi, Nimmitabel, Pheasant Creek, Pilot Mountain, Pulletop Creek, Purnamoota, Quart Pot Creek, Quirindi, Rankin's Springs, Sandy Mount, Sheep Station Creek, Shellharbour, Sidmouth Valley, Stuart Town, Sunny Corner, Temora, Tenterfield, Termeil, Tingha, Torrington, Tumbarumba, Tumut, Ungarie, Uralla, Vegetable Creek, Wagga Wagga, Walcha, Wallalda, Wellingrove, Werong Mount, Wilson's Downfall, Woodburn, Wyalong, Yalgogrin, Yambulla, Yancowinna Creek.

For Assays, Annual Report 17/176.

Tripolite, Diatomaceous Earth. Barraba, Bungonia, Cargo, Cobbadah, Cooma, Lismore, Narrabri, Newbridge, Paddy's River, Warrumbungles.

Tungsten—Wolfram, Sheelite, &c. Adelong, Albury, Armidale, Barraba, Berridale, Bingara, Bobadah, Bolivia, Boorowa, Broken Hill, Bundarra, Burrowa, Carrai, Casino, Cathcart, Cobar, Cooma, Copeton, Coppabella, Cowra, Deepwater, Eremeran Range, Euabalong, Glen Innes, Gundagai, Guyra, Harden, Hillgrove, Holbrook, Ilford, Jingellic, Kootingal, Lionsville, Manilla, Mila, Millthorpe, Mulyan, Nangerybone, Nundle, Nymagee, Oberon, Orange, Pheasant Creek, Pulletop, Purnamoota, Reid's Flat, Rockley, Scrubby Rush, Sofala, Sutton Mount, Temora, Tenterfield, Thoko, Tingha, Torrington, Tuena, Tumbarumba, Uralla, Uranquinty, Vegetable Creek, Wagga Wagga, Warrengunyah, Wellington, Wilson's Downfall, Wunglebung, Wymah, Yalgogrin, Yeoval.

For Assays, see Annual Report 17/176.

Zinc. Boorowa, Broken Hill, Casino, Cobar, Condobolin, Cootamundra, Drake, Dunedoo, Ettrema Creek, Grose River, Moruya, Orange, Rivertree, Sunny Corner, Tingha, Vegetable Creek, Wellingrove, Werong Mount.

Digitized by Google

ABBREVIATIONS USED.

Memoirs of the Geological Survey of New South Wales.

T.W.E.D., Mem. G1, 87/10	No. 1. Report on the Vegetable Creek Tin Mining District, by T. W. E. David, B.A., F.G.S., 1887, page 10.
J.B.J., Mem. G2, 01/10	No. 2. The Iron Ore Deposits of N.S.W., by J. B. Jaquet, A.R.S.M., 1901, page 10.
J.E.C., Mem. G3, 03/10 ...	No. 3. The Kerosene Shale Deposits of N.S.W., by J. E. Carne, F.G.S., 1903, page 10.
T.W.E.D., Mem. G4, 07/10	No. 4. Geology of the Hunter River Coalfield, by T. W. E. David, B.A., F.R.S., 1907, page 10.
J.B.J., Mem. G5, 94/16 ...	No. 5. Geology of the Broken Hill Lode and Barrier Ranges Mineral Field, N.S.W., by J. B. Jaquet, A.R.S.M., 1894, page 10.
J.E.C., Mem. G6, 08/10 ...	No. 6. Geology and Mineral Resources of the Western Coalfield, by J. E. Carne, F.G.S., 1908, page 10.
L.F.H, Mem. G7, 15/10 ...	No. 7. Geology and Mineral Resources of the Southern Coalfield, by L. F. Harper, F.G.S., 1915, page 10.

Mineral Resources Series.

J.E.C., M.R. No. 1, 93/20...	No. 1. Notes on Chromic Iron Ore, by J. E. Carne, F.G.S., 1898, page 20.
J.B.J., M.R. No. 3, 99/20...	No. 3. Notes on Gold Dredging, by J. B. Jaquet, A.R.S.M., 1899, page 20.
J.A.W., M.R. No. 4, 98/20...	No. 4. Report on the Occurrence of Bismuth Ores in New South Wales, by J. A. Watt, M.A., 1898, page 20.
J.A.W., M.R. No. 5, 99/20...	No. 5. Report on the Wyalong Goldfield, by J. A. Watt, M.A., 1899, page 20.
J.E.C., M.R. No. 6, 08/20...	No. 6. The Copper Mining Industry and the Distribution of Copper Ores in N.S.W., by J. E. Carne, F.G.S., second edition, 1908, page 20.
J.E.C., M.R. No. 7, 13/20...	No. 7. Mercury or Quicksilver in N.S.W., by J. E. Carne, F.G.S., second edition, 1913, page 20.
E.C.A., M.R. No. 8, 00/20...	No. 8. Report on Hillgrove Goldfield, by E. C. Andrews, B.A., 1900, page 20.
E.C.A., M.R. No. 9, 01/20...	No. 9. Report on Yalwal Goldfield, by E. C. Andrews, B.A., 1901, page 20.
E.C.A., M.R. No. 10, 01/20...	No. 10. Report on the Kiandra Lead, by E. C. Andrews, B.A., 1901, page 20.
E.C.A., M.R. No. 24, 16/20..	No. 24. The Molybdenum Industry in N.S.W., by E. C. Andrews, B.A., 1916, page 20.
E.C.A., M.R. No. 12, 08/20..	No. 12. Report on Drake Gold and Copper Field, by E. C. Andrews, B.A., 1908, page 20.
E.C.A., M.R. No. 13, 10/20..	No. 13. The Forbes-Parkes Goldfield, by E. C. Andrews, B.A., 1910, page 20.
J.E.C., M.R. No. 14, 11/20..	No. 14. The Tin Mining Industry and the Distribution of Tin Ores in N.S.W., by J. E. Carne, F.G.S., 1911, page 20.
J.E.C., M.R. No. 15, 12/20..	No. 15. The Tungsten Mining Industry in N.S.W., by J. E. Carne, F.G.S., 1912, page 20.
J.E.C., M.R. No. 16, 12/20..	No. 16. The Antimony Mining Industry and the Distribution of Antimony Ores in N.S.W., by J. E. Carne, F.G.S., 1912, page 20.
E.C.A., M.R. No. 17, 13/20..	No. 17. Report on the Cobar Copper and Gold Field, with Maps, by E. C. Andrews, B.A., 1913, page 20.
E.C.A., M.R. No. 18, 15/20..	No. 18. The Canbelego, Budgery, and Budgerygar Mines, by E. C. Andrews, B.A., 1915, page 20.

Digitized by Google

E.C.A. and M.M., M.R. No. 19, 15/20.	No. 19. Geological Survey of the Cargo Goldfield, by E. C. Andrews, B.A., and M. Morrison, 1915, page 20.
J.R.G., M.R. No. 20, 15/20..	No. 20. Report upon The Ardlethan Tinfield, by J. R. Godfrey, 1915, page 20.
L.F.H., M.R. No. 21, 16/20	No. 21. The Adelong Goldfield, by L. F. Harper, F.G.S., 1916, page 20.
	No. 22. Bibliography of Australian Mineralogy, by C. Anderson, M.A., D.Sc., 1916.
L.F.H. and J.E.H.M., M.R. No. 23, 16/20.	No. 23. The Coke Industry of New South Wales, by L. F. Harper, F.G.S., and J. E. H. Mingaye, F.I.C., F.C.S., 1916, page 20.
E.C.A., M.R. No. 24, 16/20..	No. 24. The Molybdenum Industry in N.S.W., by E. C. Andrews, B.A., 1916, page 20.
J.E.C. and L.J.J., M.R. No. 25, 19/20.	No. 25. The Limestone Deposits of N.S.W., by J. E. Carne, F.G.S., and L. J. Jones, A.S.T.C., 1919, page 20.
L.F.H., M.R. No. 26, 17/10	No. 26. Felspar in New South Wales, by L. F. Harper, F.G.S., 1917, page 10.
L.F.H., M.R., No. 27, 18/20	No. 27. The Hill End-Tambaroora Gold Field, by L. F. Harper, F.G.S., 1918, page 20.
E.F.P., M.R. p. 300.....	Mineral Resources of New South Wales, by E. F. Pittman, A.R.S.M., 1901, page 300.

Coal.

C.R., 12/20	The Coal Resources of N.S.W., by E. F. Pittman, A.R.S.M., 1912, page 20.

Records.

C.S.W., Rec. III, pt. 1, 92/1	Records of the Geological Survey of New South Wales, Vol. III, Part 1, 1892, page 1.
M.P., 82/, 87/	Mineral Products of New South Wales, 1882 and 1887.

The Minerals of New South Wales, by A. Liversidge, M.A., F.R.S. (not indexed).

Authors—Abbreviations used.

W.A.....	Anderson, W.	W.S.L.....	Leigh, W. S.
E.C.A.	Andrews, E. C.	M.M.	Morrison, M.
H.Y.L.B. ...	Brown, H. Y. L.	C.E.M. ...	Murton, C. E.
G.W.C. ...	Card, G. W.	E.F.P.	Pittman, E. F.
J.E.C.	Carne, J. E.	W.H.J.S....	Slee, W. H. J.
W.S.D. ...	Dun, W. S.	E.C.S.S. ...	Saint Smith, E. C.
R.E.	Etheridge, R.	G.A.S.	Stonier, G. A.
P.T.H.	Hammond, P. T.	O.T.	Trickett, O.
L.F.H.	Harper, L. F.	J.A.W. ...	Watt, J. A.
J.B.J.	Jaquet, J. B.	E.C.W. ...	Whittell, E. C.
L.J.J.	Jones, L. J.	C.S.W.....	Wilkinson, C. S.
C.O.G.L. ...	Larcombe, C. O. G.	L.Y.	Young, Lamont.
J.C.H.M. ...	Mingaye, J. C. H.		

Reports published in the Annual Reports of the Department of Mines.

C.S.W., 80/10	C. S. Wilkinson, 1880, page 10.
R., 80/10	Report by Mining Warden, Registrar, or Inspector of Mines, 1880, page 10.
A., 80/10	Assay, 1880, page 10.

Digitized by Google

LOCALITY INDEX.

PART I.

The Prospectors' Guide, issued in 1919, contains a coloured map showing the distribution of the principal minerals in New South Wales.

Tables, giving particulars of minerals produced, are published in the Annual Reports, Department of Mines, commencing with the Report for the year 1875, which also supplies a summary of production prior to that year.

ABERCROMBIE RIVER. Jerry's and Piesley's Flats, Curragh, Sounding Rock, 6 miles north-west of Tuena. From Mt. Werong to junction with the Lachlan River. E.F.P. 99/168; M.P. 82/122; R. 75/61, 83/32, 99/22, 01/14, 02/15, 05/11, 06/16. *Gold, Diamonds.*

ABRECROMBIE CAVES. [*See* Trunkey.]

ABERDEEN RANGE. [*See* Barraba.]

ABERFOYLE RIVER. Parish of Rampsbeck, county of Clarke, 36 miles north-east of Armidale. J.E.C. M.R. No. 16, 12/25; R. 80/139, 90/105, 07/62; A. 06/178. *Antimony.*

E.F.P. M.R. p. 132; J.E.C. M.R. No. 14, 11/38; Rec. VI, pt. 4, 00/312, 315. *Platinum, Tin.*

Ward's Mistake, Parish of Allingham, county of Clarke, 40 miles north-east of Armidale. J.E.C. M.R. No. 6, 08/304; R. 10/49, 11/55. *Copper, Silver; Gold, a trace.*

Parishes of Nowland and Warren, 30 miles north-east of Armidale. J.E.C. and L.J.J., M.R. No. 25, 19/206. *Limestone.*

ABINGTON CREEK. Sutton's Gully, parish of Sandy Creek, county of Hardinge, 24 miles east-north-east of Bundarra; J.E.C. M.R. No. 16, 12/25. *Antimony-Silver.*

ACACIA. Acacia Dam. [*See* Broken Hill.]
Acacia Creek. [*See* Wilson's Downfall.]

ADAMINABY. Kyloe Estate, parish of Seymour, county of Wallace, 2 miles south of Adaminaby, 17 miles south-east of Kiandra. J.E.C. M.R. No. 6, 08/383, R. 05/45, 06/48, 07/53, 09/48, 10/48, 11/53, 12/49, 73, 13/52, 14/54, 84; M.P. 82/102. *Copper, Tin.*

ADELONG. [*See* Batlow, Upper Adelong.] Parishes of Adelong and Calafat, counties of Wynyard and Euadera. Parliamentary papers, Gold Fields, N.S.W., 1873-4. C.S.W. 77/199, 78/116; J.E.C. Rec. 1, 89/37, 39; J.B.J. 04/71; L.F.H. M.R. No. 21, 1916; Rec. VI pt. 4, 00/195, 202, 234, 239; R. 75/90, 76/100, 116, 78/136, 80/222, 81/68, 83/82, 94/75, 95/22, 96/11, 97/12, 98/37, 99/32, 00/25, 01/25, 02/28, 82, 03/29, 26, 74, 04/26, 05/23, 06/24, 07/17, 09/14, 10/14, 11/15, 93, 12/14, 13/16, 14/15, 15/14, 16/14, 82, 17/12, 18/11; Dredge 03/29, &c., to 16/25, 17/11, to 17/21, 18/19. *Gold.*

Digitized by Google

Wondalga, south of Adelong. R. 79/126, 01/87, 04/26, 08/14, 16/82. *Gold.*
R. 79/46; M.P. 82/33; E.F.P. M.R. p. 263; J.A.W. M.R. No. 4, 1898. *Bismuth.*
J.E.C. 97/169; M.R. No. 2; E.F.P. M.R. p. 297 *Tungsten, Sheelite.*
Assay, 96/144. *Nickel.*
M.P. 62/86. *Silver.*

Calafat, north of Adelong. R. 16/49. [*See* Gundagai.] *Copper.*

Mount Adra. Hillas, Nacka Nacka and Sharp's Creeks, parishes of Ellerslie, Yaven, Nacka Nacka, &c., county of Wynyard, 10 to 14 miles north-west of Adelong, 6 miles east of Tarcutta. C.S.W. 76/151; R. 79/126, 03/26, 09/14. *Gold.*

Bangandang, parishes of Ellerslie and Euadera, 8 miles north-west of Adelong. R. 10/14, 86, 11/15, 93, 12/14, 14/15, 15/85, 16/82, 17/12, 18/11, 82. *Gold.*
8 miles north-east of Adelong. Assay 06/179. *Iron.*

Black Springs, Adelong Crossing, Murrumbidgee River. [*See* Gundagai.]
Parish of Mundarlo. E.F.P. 81/140. *Gold.*
Parishes of Willie Ploma and Bangus. Adelong Creek Dredge, 17/11. *Gold.*

ADJUNBILLY. [*See* Tumut.]

ADRA MT. [*See* Adelong.]

ÆLLALONG. Myall Range, parish of Ællalong, county of Northumberland. T.W.E.D. 89/212. *Salt.*

ALBERT GOLDFIELD. Rec. VI, pt. 4, 00/191.

ALBERT WATER HOLES. [*See* Tottenham.]

ALBERTA (Kantappa). [*See* Thakaringa.]

ALBURY. Black and Nail Can Ranges, Bungambrawatha Creek, parishes of Mungabarina and Albury, county of Goulburn. E.F.P. 98/149; M.R. p. 15; E.C.W. 00/108; Department of Mines paper, 1901; Rec. VI, pt. 4, 00/224, 245; R. 95/22, 97/36, 05/42, 07/16, 11/15, 15/14, 18/11. *Gold.*

Splitter's Creek, Black Range, 7 miles north of Albury. R. 86/77, 12/14. *Gold.*

Mount Terrible, May Day Hill, &c. R. 91/104, 105, 05/23, 42, 79. *Gold, Silver.*

Rotherfield, Khankoban, Eskdale, Upper Murray, parishes of Cumboroona and Wyndham, 15 miles north-east of Albury. J.B.J. 95/174; R. 96/30; Bores 14/78, 15/74. *Gold, Tin.*

Parish of Mullanjandra, 18 miles north-east of Albury. R. 12/54, 13/58, 14/59. *Tin.*

Thurgoona, Hawksview Estate, parish of Thurgoona. R. 08/14, 09/14, 10/14, 11/15, 12/14, 13/14, 15/14, 16/13. *Gold.*

Jindera, parish of Jindera. R. 91/105. *Gold.*

Albury, 4 miles north-west. J.E.C. M.R. No. 15, 12/50. *Tungsten.*

Parish of Bungowannah, county of Hume. R. 87/86, 88/92. *Gold.*

Digitized by Google

ALECTOWN. Alick's Flat, parishes of Houston and Davison, county of Kennedy. R. 89/66, 133, 91/82, 88, 94/24, 95/20, 99/28, 01/22, 06/12, 07/14, 08/12. *Gold.*

Coradgery, parish of Wombin. R. 05/18, 06/12, 07/12. *Gold.*

Parish of Mickibri, 4 miles north-west of Alectown.

Parish of Limestone, 8 miles south-west of Alectown, 11 miles north-north-west of Parkes. J.E.C. and L.J.J. M.R. No. 25, 19/259. *Limestone.*

ALLEN, MOUNT. [*See* Mount Hope.]

ALMA DAM. [*See* Trunkey.]

ALMA HILL. [*See* Braidwood.]

AMERICAN YARDS. [*See* Tumbarumba.]

AMOSFIELD. [*See* Wilson's Downfall.]

AMPHITHEATRE. [*See* Cobar.]

ANDREWS, MOUNT. [*See* Hill End.]

ANGOPERRAN. [*See* Bolivia and Deepwater.]

ANGULA CREEK. [*See* Bingara.]

ANACONDA. [*See* Melrose.]

ANNANDALE. [*See* Blayney.]

ANN RIVER. [*See* Kookarabooka.]

APPLE TREE FLAT or Mullamuddy. [*See* Mudgee.]

APPIN. M.R. No. 25, 19/214; A. 06/180. *Limestone.*

APPOLYON VALLEY, north of Broken Hill. [*See* Puruamoota.]

APSLEY. [*See* Rockley, Wellington, and Walcha.]

ARALUEN. Parish of Araluen, county of St. Vincent.

Alluvial workings extend for 10 miles down the Araluen Creek.

M.P. 82/24; E.F.P. M.R. p. 62.

R. 75/45, 81, 76/62, 77/93, 95/24, 03/28, 04/28, 05/21, 06/22, 13/24, 14/25, 15/23. *Gold.*

Dredge 99/34, &c., to 16/25, 17/20, 18/19.

Bell's Creek. Private land. R. 75/82, 93/22, 95/24, 03/22, 07/24, 09/21, 18/16. *Gold.*

Goodenough's Gully, parish of Milo, east of Por. 104, south-east of Araluen. R. 17/17, 18/16. *Gold.*

ARCADIA. A. 16/222. *Gypsum.*

ARDLETHAN. [*See* Grong Grong.]

Mirrool Creek, parishes of Warri and Ramsay, county of Bourke, parish of Yalgogoring county of Cooper, 35 miles north-north-east of Narrandera.

R. 12/13, 13/14, 14/15, 15/14, 16/13, 17/12. *Gold.*

E.F.P. 12/173; L.F.H. 12/180; J. R. Godfrey, M.R. No. 20, 1915.

R. 12/53, 13/57, 86, 14/58, 86, 15/53, 85, 16/53, 83, 17/46. *Tin.*

Bygoo, 15 miles north of Ardlethan; Mount Charles, 6 miles west; Gow Hill, 7 miles south-west. *Tin.*

Assay. 13/188. *Bismuth.*

E.C.A. M.R. No. 24, 16/58. *Molybdenite.*

Kildary Station, parishes of Yithan and Ardlethan, county of Bourke, north of Ardlethan. J.B.J. 03/128; J.E.C. 04/138.

R. 00/24, 01/24, 02/20, 77, 82, 05/19, 06/13, 07/15, 08/12. *Gold.*

ARGALONG. [*See* Tumut.]

Digitized by Google

ARMIDALE. Herbert Park, Guyra Road, parish of Donald, county of Sandon. 9 miles north-east of Armidale. R. 75/60, 76/103, 78/120, 93/23 *Gold.*

Near and 14 miles north and west of Armidale. E.F.P. M.R., p. 238. Assay 06/180, 12/197. *Manganese.*

Gara Falls, 12 miles north-east of Armidale; Back Creek 7 miles from Birlong. J.E.C. M.R. No. 15 12/50. *Tungsten.*

J.E.C. 97/149, M.R. No. 1. *Chrome.*

Rec. VI, pt. 4 00/214. *Iron.*

Puddledock, parishes of Springmount and Tilbuster, county of Sandon; 12 miles north-east of Armidale. R. 75/50, 76/104, 78/120, 95/27, 97/44, 15/19, 16/19. *Gold.*

J.E.C. M.R. No. 16, 12/43; Assay 06/178. *Antimony.*

Armidale, near and 25 miles north. Cameron's Creek. C.S.W. 89/206; J.E.C. M.R. No. 16, 12/25, 31. *Antimony.*

Tilbuster, parishes of Springmount and Tilbuster, county of Sandon. 6 miles north of Armidale. R. 85/84, 95/27, 05/16, 11/20, 12/19, 14/21, 15/19, 16/19. *Gold.*

J.E.C. 98/159; R. 10/44, 12/44, 13/48, 14/49, 15/45 *Silver.*

Tait's Gully. R. 01/50, 03/43, 04/42, 07/47, 11/48. *Gold, Silver.*

ARRAMAGONG. [*See* Grenfell.]

ARROWSMITH, MOUNT, county of Evelyn, 26 miles south-west of Milparinka. J.E.C. M.R. No. 6 99/48. *Copper.*

ARTHUR. [*See* Trunkey.]

ASHFORD. [*See* Coal Index.] Parish of Ashford, county of Arrawatta; 30 miles north of Inverell.

R. 91/114; Assay 03/140. *Silver, Copper, Bismuth, Arsenic.*

Fraser's Creek. J.E.C. M.R. No. 16 12/25, 31. *Antimony.*

Mandowie paddock, parish of Mandoe (?), 20 miles north-west of Ashford. J.E.C. M.R. No. 6, 08/327. *Copper and Silver.*

Parishes of Ashby, Myall, &c. R. 11/65. *Fireclay.*

Ashford Caves, parish of Macintyre, 12 miles north-north-west of Ashford. J.E.C. 15/174; M.R. No. 14, 11/70; J.E.C. and L.J.J. M.R. No. 25, 19/146; R. 15/175. *Limestone.*

R. 16/63 *Phosphates.*

ATTUNGA. Attunga Creek, parishes of Attunga, Gill and Burdekin, county of Inglis, 2 miles south-east to 6 miles north-east of Attunga.

J.E.C. and L.J.J. M.R. No. 25, 19/117, 254. *Limestone.*

Limestone Gully, parish of Bubbogullion, county of Inglis, 5 miles west of Attunga. *Limestone.*

South of Attunga. M.P. 82/103. *Tin.*

Serpentine belt between Attunga and Manilla.

J.E.C. 97/149, M.R. No. 1, 1898. Assay 07/177, 16/220. *Chromite.*

Mount Gulligal, parish of Attunga. E.F.P. M.R. p. 224 *Nickeliferous Opal.*

Parish of Gill, 5 miles north-east of Attunga and 9 miles east and 4 miles south. J.E.C. M.R. No. 6, 08/328; R. 03/47, 04/46, 05/45, 77, 06/84, 07/55, 09/50, 11/55, 15/51, 16/19, 50. *Copper, Gold, Silver. Iron Bismuth.*

E.C.A. M.R. No. 24, 16/36, 122, 17/159. *Molybdenum.*

R. 03/141, 8 miles north of Attunga *Manganese.*

Assay 16/222, R. 17/55, 18/63. *Mangnesite.*

Digitized by Google

AUBREY, MOUNT, parish of Hyandra, county of Gordon, 20 miles north-east of Parkes. R. 91/76. *Gold.*

AUBURN VALE. [*See* Inverell.]

AVERY'S CREEK. [*See* Coramba.]

AVISFORD. [*See* Mudgee.]

BABINDA. [*See* Nymagee.]

BACK CREEK. [*See* Blayney, Coramba, Gundagai, Gundaroo, Major's Creek, Newbridge, Rockley, Sofala, The Valley, Tuena.]

BACKWATER. [*See* Kookarabooka.]

BADJERRIGARN. Parish of Badjerrigarn, County of Farnell, near Corona, 50 miles north of Broken Hill. J.E.C. MR. No. 6, 99/49, M.R. No. 14, 11/252; R. 90/126. *Copper, Tin.*

BADJER BRUSH. Parish of Blenheim, county of Westmoreland, 6 miles north-east of Oberon; Badjer Brush Creek, parish of Yethelme, county of Roxburgh. *Gold.*

BADJERY'S SWAMP. [*See* Bombala.]

BAGO CREEK. [*See* Tumbarumba.]

BAKER'S CREEK. [*See* Hillgrove.]

BAKER'S HILL. [*See* Glen Innes.]

BALACLAVA. [*See* Broken Hill.]

BALALA. [*See* Uralla.]

BALD HILL. [*See* Hill End, Bathurst, Bourke, Forbes, and Stuart Town.]

BALD NOB. [*See* Glen Innes.]

BALD ROCK CREEK. [*See* Vegetable Creek.]

BALLANDEAN. [*See* Tenterfield.]

BALLIMORE. [*See* Dubbo.]

BALLINA. Beaches along coast, counties of Rous and Richmond. C.S.W 89/202; G.A.S. 95/173; R. 88/117, 89/131, 12/20, 14/24, 17/17. [*See* Beach Sands.] *Gold, Tin.*

Evans' Head, county of Richmond. E.F.P. M.R. p. 17. *Platinum.*

Evans' River. G.A.S. 94/127; Rec. IV, pt. 1, 1894, 9 miles south of Ballina. *Gold.*

Parish of Tuckombil, county of Rous, 6 to 9 miles west of Ballina. *Gold.*

Parish of Teven, por. 48, county of Rous. D.W. Munro 05/94. *Opal.*

BALOO ARM. [*See* Tumut.]

BALRANALD. County of Kilfera.

Paika Lake, north of Balranald. *Gypsum.*

BANGALORE CREEK. [*See* Goulburn.]

BANGANDANG. [*See* Adelong.]

BANGADILLY. Parish of Bangadilly, county of Camden, R. 15/50 *Copper.*

BANOONA SWAMP. Gypsum Palace Inn, north boundary, county of Manara. C.S.W. 84/146. *Gypsum.*

BARA CREEK AND GAP. [*See* Mudgee.]

BARATTA. [*See* Condobolin.]

BARBADINE CREEK. [*See* Peak Hill.]

BARBER'S CREEK. [*See* Marulan.]

BARBER'S CREEK STATION. Parish of Bumballo, county of Camden. J.R.J. Mem. G. 2, 01/133. *Iron.*

Digitized by Google

BARBIGAL. [*See* Dubbo.]

BARE HILL. [*See* Kookarabooka.]

BARGO. [*See* Picton.]

BARIGAN. North of Stormy Mount, parish of Budden, or Burrumbelong, county of Phillip, 6 miles south-east of Barigan. J.E.C. and L.J.J. M.R. No. 25, 19/305. *Limestone.*

BARK HUT. [*See* Gundagai.]

BARMEDMAN. Ada Hill, &c. Parish of Mandamah, county of Bland. M.P. 82/24; R. 82/57, 60, 83/73, 95/21, 99/30, 00/24, 03/17. *Gold.*

Mandamah, parish of Lange Kal Kal, county of Bourke, 4 miles north-west of Broken Dam, south-south-west of Barmedman. W.A. 89/234; J.E.C. M.R. No. 14, 11/276; R. 81/138, 85/70, 88/78. *Tin.*

Junction Mine. *Mercury.*

Reefton, parishes of Gidgingidginbung and Culingerai, county of Bland, 8 miles south-east of Barmedman. R. 94/24, 76, 95/21, 88, 01/24, 05/19, 08/12, 12/12, 16/13. *Gold.*

Narraburra, between Temora and Barmedman. R. 16/44. *Silver; Lead.*

BARNEY DOWNS. [*See* Tenterfield.]

BARRABA. Mt. Moore, parish of Ironbark, &c., county of Darling. Allalong Serpentine Belt. W.A. 88/179; Rec. VI, pt. 4, 00/200; R. 06/20. *Gold.*

Parish of Barraba, &c. 1½ miles west of Barraba, 7 miles north-east, 12 to 16 miles east. M.P. 82/107, 114; J.E.C. 97/149; M.R., No. 1, 1898; R. 04/151, 06/178, 11/65, 13/188, 14/67, 214. *Chromite.*

Three miles north of Barraba. R 17/47. *Tin* (unprofitable).

Bell's Mountain, Nandewar Range, parish of North Barraba, 8 miles north-west of Barraba. E.F.P. M.R. p. 426, 430, 81/142; G.W.C. and W.S.D., Rec. V, pt. 3, 97/146; Rec. VI, pt. 4, 00/304; R. 08/60, 10/59, 17/55, 18/62; Assay 96/146. *Tripolite.*

District. R. 06/56, 178. *Antimony.*

Crow Mountain, Black Mountain, parishes of Eumur and Welsh. G.A.S. 89/94, 95/167; R. 95/28, 00/30, 05/17, 13/22, 14/23. *Gold.*

J.E.C. M.R. No. 7, 13/17. *Mercury.*

Aberdeen Range, Tea Tree Creek, Manilla River, parish of Newry, 7 to 9 miles south-east of Barraba. W.A. 88/182; E.F.P. M.R., p. 68; M.P. 87/29; Rec. VI, pt. 4, 00/132; R. 75/55, 04/23, 92, 05/17, 16/19, 17/16. *Gold.*

Ironbark, Nangahrah, Nangahrah Creek, Wood's Reef, parishes of Tiabundie and Wood's Reef, 6 and 8 miles east of Barraba. W.A. 88/182; J.E.C. M.R. No. 6, 08/326, 329, 333; R. 75/55, 95/28, 99/69, 01/65, 04/46, 05/17, 45, 11/22, 15/20, 17/43. *Copper, Gold, Silver.*

J.E.C. 97/149; M.R. No. 1, 1898; R. 75/55; Assay, 04/151, R. 09/60, 13/66, 15/62. *Chromite.*

J.E.C. M.R. No. 15, 12/86; Crow Mountain, R. 18/58. *Sheelite.*

Wood's Reef. R. 16/62, 18/62. *Asbestos.*

Assay 16/220 *Manganese.*

Parish of Tiabundie. M.P. 82/103; R. 18/41, parish of Warrabah, 99/72. *Tin, Copper.*

Digitized by Google

Limekilns, Heads of Eumur and Crow Mountain Creeks, parishes of Welsh and Wilson, 16 to 17 miles south-south-east and south-east of Barraba. J.E.C. and L.J.J. M.R. No. 25, 19/220. *Limestone.*

Namoi River, parish of Lowry, 21 miles south-east of Barraba. M.R. No. 25, 19/219. *Limestone.*

Paling Yards, parish of Tiabundie, county of Darling, and parish of Piedmont, county of Murchison, 7 miles north-east of Barraba. W.A. 88/182; J.E.C. 97/150; M.R. No. 1, 1898. *Gold, Chromite.*

20 miles south of Barraba. Assay 16/220 *Chromite.*

Gulf and Oakey Creeks heads, parish of Capel, county of Murchison, 12 to 22 miles north-east of Barraba; E.F.P. M.R. p. 176; J.R.C. M.R. No. 6, 08/317, 322, &c.; R. 96/11, 98/70, 99/69, 01/55, 03/47, 04/46, 06/49, 07/55, 09/60, 110, 10/49, 11/55, 14/55, 16/50, 17/86. *Copper.*

BARRACK CREEK. [*See* Top Bingara.]

BARRAGAN or Barringun. [*See* Canowindra.]

BARRIER RANGE. [*See* Broken Hill.] C.S.W. Report on Barrier Range, 1884; J.E.C. M.R. No. 14, 11/242. *Silver, Tin.*

J.E.C. M.R. No. 6, 08/p. 17, &c. *Copper.*

BARRINGTON. [*See* Gloucester and Copeland.] Parish of Bindera, county of Gloucester, 10 miles north-west of Gloucester. E.F.P. 77/10; C.S.W. 78/159; R. 77/110, 79/173. *Gold.*

BARROWDALE. [*See* Undercliff.]

BARTLEY'S CREEK, or Bartlett's. [*See* Parkes.]

BASIN CREEK. Dora Dora, Home Creek, &c., parishes of Dora Dora and Vautier, county of Goulburn, 15 miles south-east of Holbrook. E.F.P. M.R. p. 146; J.E.C. 94/114; M.R. No. 14, 11/259, 261; R. 92/43, 93/42, 10/27, 14/59, 15/54, 16/54. 17/47, 18/46; Mt. Jergyle Dredge, 06/27. *Tin.*

BASKET SWAMP. [*See* Tenterfield.]

BATEMAN'S BAY. Bimbimbie, parish of Tomalga, county of St. Vincent' between Mogo and Moruya. R. 91/93, 92/19, 95/25, 00/19, 02/25, 03/23, 04/23, 05/78, 06/22, 07/24, 08/21, 09/22, 10/23, 11/25, 12/22, 13/24, 14/26, 84, 15/23. *Gold.*

Sandy Creek, between Mogo and Bimbimbi. R. 95/25. *Gold.*

Mogo, parishes of Goba and Bateman. LY. 79/223; J.E.C. 95/140; R. 75/47, 77 91, 86/74, 95/25, 96, 32, 98/42, 43, 99/36, 00/19, 05/22, 07/25, 08/22, 13/25, 14/26, 15/24, 16/22. *Gold.*

Cabbage Tree Creek, Big Burrowang Hill, &c. J.E.C. 94/115. *Gold.*

Currowan, Clyde or Clyne Mallow Creek, Nelligen and Sugarloaf, parishes of East Nelligen and Carrowan, north-west of Bateman's Bay. W.A. 91/253; R. 91/93, 95/25, 96/32, 99/35, 03/24, 06/23, 09/22, 10/23. *Gold.*

R. 98/70, 99/68. *Copper.*

Assay 06/178. *Barytes.*

Brimbramalla, Bimberamala Creeks, parishes of Currock and Mogood, 10 miles north of Nelligen. W.A. 89/233, 91/253; R. 91/93, 100, 95/26, 96/11, 02/26, 03/24, 04/24, 90, 05/21, 77, 06/22, 07/25, 81, 08/22, 09/22, 10/23, 11/25, 13/25, 14/26, 15/23. *Gold.*

Cockwhy Creek, parish of Clyde, 13 miles north of Bateman's Bay. R. 08/22, 09/22, 10/23, 14/26, 15/24. *Gold.*

Digitized by Google

BATHURST. Bathurst to Bald Hills, parish of Bathurst, county of Bathurst. E.F.P. M.R. p. 3; Rec. VI, pt. 4, 00/242; R. 95/17. *Gold.*

Bald Hills. R. 09/60, 12/62, 14/68, 15/64.

District. M.P. 82/108, 118, 119; R. 15/45. *Iron, Nickel, Manganese, Silver.*

Clear Creek, Peel, Mt. Conqueror, parish of Peel, county of Roxburgh, 10 miles north-east of Bathurst. E.F.P. 81/159; R. 95/17, 99/23, 08/15, 09/15, 59, 10/15, 11/16, 12/15, 13/16, 14/17. *Gold.*

Mount Grosvenor, near Peel. R. 82/35; M.P. 82/32, 86. *Silver* (poor).

Keloshiel, near Eglinton, county of Roxburgh, north-west of Bathurst. J.E.C. M.R. No. 6, 08/149; Rec. VI, pt. 4, 00/243. *Copper.*

Rocky Mount, parish of Apsley, south of Bathurst. R. 17/39. *Copper.*

Winburndale Rivulet, Glanmire, Fontana, Napoleon and Green Swamp. Parishes of Melrose and Eskdale, county of Roxburgh, 9 miles east of Bathurst. M.P. 82/22; J.E.C. M.R. No. 6, 08/144; Rec. VI, pt. 4, 00/242; R. 75/58, 59, 77/114, 80/81, 84/54, 03/11, 05/11, 09/15, 10/15, 11/16, 12/15, 13/16, 18/12.

Also parish of Yetholme, ½ mile from Glanmire. *Gold, Silver, Copper.*

18/78. *Arsenic.*

E.F.P. M.R. p. 238; Assay 06/180, 16/220 *Manganese.*

C.S.W. 91/215; Assay 83/38. *Iron.*

Bald Hills. R. 15/64, 18/64. *Pottery Clay, Fireclay.*

Caloola, Queen Charlotte Vale, Summer Hill Creek Junction, parishes of Lowry and Ponsonby, county of Bathurst, north-east of Egan, 13 miles south-south-west of Bathurst. [*See* Rockley and Limekilns.] J.E.C. and L.J.J. M.R. No. 25, 18/184. *Limestone.*

BATHURST LAKE. [*See* Tarago.]

Parish of Covan, county of Argyle, 2 miles north-west of Lake Bathurst, parish of Mulwaree, 2 miles south-west of Millindel Creek, parish of Nadgigomar, 10 miles south-east of Lake Bathurst. M.R. No. 25, 19/8, 136, 142. *Limestone.*

BATLOW. Reedy Flat, parishes of Batlow and Hindmarsh, county of Wynyard, 14 miles south-south-east of Adelong. J.E.C. 95/138; R. 82/73, 95/23, 99/32, 03/26, 06/14, 07/17, 11/15, 12/14, 13/15, 14/16, 15/14, 17/12. *Gold.*

Gilmore Valley. R. 09/14. *Gold.*

Gilmore Valley and Creek, parish of Batlow, 12 miles south to south-south-west of Tumut. M.R. No. 25 19/349. *Limestone.*

BATTERY CREEK. [*See* Vegetable Creek.]

BAXTER'S CREEK. At junction with Shoalhaven River.

BAULOORA. [*See* Cootamundra.]

BAW BAW. [*See* Goulburn.]

BEACH SANDS. [*See* Ballina, Richmond River, and Woodburn.] Macleay River, Swansea, Lake Macquarie, Ulladulla, Ballina, Brunswick River, Coff's Harbour. *Gold, Silver, Tin, Platinum.*

(Black Head, Gerringong, Murrumerang, 12 miles south of Ulladulla, Shell Harbour, Seal Rock Bay, contain no gold of value. R. 07/176.)

E.F.P. 80/245, M.R. p. 8; C.S.W. 89/203; G.A.S. 94/129; Rec. IV, pt. 1, 1894; J.E.C. 95/149, 96/104, 98/165, 99/179, Rec. V, pt. 2, 1897, R. 76/116, 93/24, 94/29, 06/20, 21, 12/20.

North of Evan's Head, Byron Bay, &c. E.F.P. M.R. p. 77; R. 91/130. *Platinum.*

Digitized by Google

BEARBONG RUN. Parish of Dilly, county of Gowen, 31 miles south-west of Coonabarabran. *Gold.*

BEARDY RIVER. [*See* Vegetable Creek.]

BEARDY PLAINS. [*See* Glen Innes.]

BEAR HILL. [*See* Kookarabooka.]

BEAU DESIRE. [*See* Mudgee.]

BEE MOUNTAIN. [*See* Cobar.]

BEECHWOOD. Hastings River. West of Wauchope, county of Macquarie. Five Day Creek. 14 miles south-west of Beechwood. Assay 06/181 *Tin.*

BEGA. Parish of Bega, &c., county of Auckland. C.S.W. 78/154; R. 98/44, 01/20, 15/24, 17/19, 18/17. *Gold.*

3 miles east of Bega. R. 99/37. *Silver* (trace).

Black Range. Parish of Kameruka, county of Auckland, 5 to 7 miles south of Bega. E.C.A. M.R. No. 24 16/12, 26, 35, 36, 60; R. 77/98, 89/86, 14/214. *Gold, Silver, Bismuth, Molybdenite.*

Nelson Diggings, Robinson's Hole, Doctor George Mountains, parish of Tanja, county of Dampier, 8 miles north-east of Bega.

J.E.C. 04/140; M.R. No. 14, 1911/282; R. 85/75, 91/94, 95/25, 97/42, 03/24, 16/22, 17/19. *Tin, Gold.*

Cohen's Lake. Clarke's Creek, near Tathra, parish of Wallagoot, county of Auckland, east of Bega. R. 89/86, 04/90. *Gold.*

BELAMBIL CREEK. [*See* Murwillumbah.]

BELARA. [*See* Broken Hill.]

Parish of Worobil, county of Bligh, 5 miles from Goolma, 17 miles west of Gulgong. J.E.C. M.R. No. 6, 08/286, 299.

R. 75/71, 80/98, 88/72, 89/65, 05/45, 06/47, 07/52, 08/47. *Copper, Silver, Gold.*

BELCONEN. Parish of Weetangera, county of Murray, 17 miles North-north-west of Queanbeyan. J.B.J. 93/119; E.F.P. M.R., p. 189; M.P. 82/86, 88. *Galena* with *Silver* (trace.)

BELIMBLA CREEK. [*See* Nerrigundah.]

BELL. [*See* Lewis Ponds.]

Near Hartley Vale. Assay 07/180. *Iron.*

BELL MOUNTAIN. [*See* Cobbadah.]

BELL RIVER. [*See* Molong and Wellington.]

BELL'S CREEK. [*See* Araluen, Braidwood, Moonan.]

BELLANGRY. [*See* Gundle.]

BELLBROOK. [*See* Kempsey.]

BELLINGEN RIVER. Head waters of Nambucca and Taylor's Arm, county of Raleigh. C.S.W. 89/204; J.E.C. M.R. No. 16, 12/25, 27; R 90/111. *Antimony.*

R. 08/20 *Gold.*

BELLTREES. Assay 06/179. *Iron.*

BELMORE. [*See* Canowindra and Woodstock.]

BELUBULA RIVER. Licking Hole and Copper Mine Creeks, Liscombe Pools, Sugarloaf, parish of Malongulli, county of Bathurst, 10 to 16 miles east of Canowindra, 18 miles west-south-west of Carcoar. J.E.C. M.R. No. 6, 08/110, 170, 274, 275; E.F.P. M.R., p. 152. *Copper.*

M.P. 82/107 *Iron.*

Digitized by Google

Balubula or Chiefden Caves, Licking Hole Creek Caves, Liscombe Creek, Limestone Creek, parishes of Malongulli, Carlton, Hampton, and Walli; 6 to 10 miles north of Woodstock.
T. and C. Journal, 9th October, 1876; C.S.W. Rec. III, pt. 1, 1892; O.T. 08/172; M.R. No. 25, 19/7, 177, 178, 180, 184.
Hot Spring, Limestone.

Limestone Creek, parish of Walli. J.E.C. 92/149; M.P. 82/107.
Iron in Limestone.

The Needles. R. 89/57. 24 miles from Cancoar *Gold.*

Parish of Malongulli. Copper Mine Creek. R. 16/62. *Barytes.*

BEN BULLEN. [*See* Coal Index.]

Parish of Ben Bullen, county Roxburgh. J.E.C. Mem. G. 6, 08/243; L.J.J. 14/210; M.R. No. 25, 19, 215; R. 01/62.
Limestone, Coal, Kerosene Shale.

The Knob. J.E.C. Mem. G. 6, 08/249. *Gold.*

Limestone Swamp. Parishes of Turon and Dulabree, county of Roxburgh. Coolamigal Creek, parish of Coolamigal, 9 miles W.S.W. to 10 miles S.W. of Ben Bullen. J.E.C. and L.J.J. M.R. No. 25, 19/318, 322. *Limestone.*

BENDEMEER. E.F.P. M.R. p. 238. *Manganese.*

J.E.C. 97/149, M.R. No. 1. *Chromite.*

Giant's Den, Hall's and Spring Creeks, parish of Hall, county of Darling, 11 miles north-west of Bendemeer. M.P. 82/102; Rec. VI, pt. 4, 00/200; E.C.A. 04/144; J.E.C. M.R. No. 14, 11/290; R. 76/68, 90/110, 91/117, 95/60, 97/12, 05/47, 06/51, 07/57, 12/53, 13/56, 14/57, 15/53, 16/52, 17/45, 18/44. *Tin.*

Moonbi Range, Watson's Creek, parish of Haning, county of Inglis, 11 to 14 miles north-west of Bendemeer. E.F.P. 79/225; J.E.C. M.R. No. 14, 11/290, 335; R. 89/105, 04/49, 06/51, 11/57, 14/57, 16/52, 17/45; dredge 07/30, &c., 17/23. *Tin.*

R. 99/77. *Diamonds.*

Carlisle's Gully, Muluerindie, north of Bendemeer. M.P. 82,103.
Gold.

Mount Tarā, Muluerindi or Macdonald River, parish of Congi, county of Inglis, 10 miles east of Bendemeer. R. 91/117. *Gold.*

BENDINNI CREEK. [*See* Bowra.]

BENDITHERA. Benditherа Caves. Con. Ck. Deua River, parishes of Uranbene and Deua, county of Dampier, 36 miles south of Braidwood. C. Sturt's two Expeditions into Southern Australia, 1884, XXXIX, Vol. 1. W.S.L. 90/310; W.A. 91/252; O.T. 97/Appendix; Papers M. 91/5,029, 00/197; M.R. No. 25, 19/217. *Silver, Limestone.*

BENDOVER or Bengenover. [*See* Bingara.)

BEN LOMOND. [*See* Kookarabooka.]

Beresford. [*See* Bombala.]

BERLANG. Parish of Tallanganda, county of St. Vincent, south-west of Major's Creek. R. 79/119. *Gold.*

BERMAGUEE or Bermagui. Montreal. Wallaga Lake, &c., parishes of Bermaguee, county of Dampier. R. 80/131, 85/76, 95/25, 00/20.
Gold.

Cobargo. Parish of Narira, county of Dampier, 10 miles west of Bermaguee. R. 03/57, 143, 06/60, 07/66, 09/60, 10/59, 11/66, 12/61, 13/25, 66, 14/26, 15/24. *Gold.*

Narira. Parish of Narira. R. 06/60. *Barytes.*

Digitized by Google

Brassknocker Creek, west of Cobargo. R. 06/23, 07/81, 09/22, 92, 10/23, 11/25, 86, 15/83. *Gold.*

Coolagalite Creek. Parishes of Bermaguee and Cadjangarry. J.E.C. 94/115; R. 90/88, 89, 95/25, 03/24, 04/24, 05/22, 06/23. *Gold.*

BERRICO CREEK. [*See* Copeland.]

BERRIDALE (Glenbrook). Wambrook Station, parish of Gygederick, county of Wallace, 7 miles from Berridale. J.E.C. M.R. No. 6, 08/375, 378, 396; R. 17/42. Parish of Arable, south-east of Berridale, M.R. No. 6, 08/388. *Copper.*

Parish of Coolamatong, 1¼ miles south south-west of Berridale. J.E.C. 97/169; M.R. No. 15, 12/50, 78; R. 91/91, 07/65. *Wolfram Sheelite.*

BERRIMA. County of Camden. M.P. 82/108. *Iron.*

BERTHONG. [*See* Wallendbeen.]

BERYL. [*See* Gulgong.]

BETHUNGRA. Parish of Bethungra, county of Clarendon, 12 miles south-west of Cootamundra. R. 10/59, 12/61. *Barytes.*

Parish of Billabung, 2 miles south-west of Bethungra, and parish of Bethungra, 6 miles north of Bethungra. M.R. No. 25, 19/205. *Limestone.*

BETTS HILL. [*See* Kootingal.]

BEWLEY OR ENDRICK RIVER. [*See* Narriga.]

BIBBENLUKE. [See Bombala.]

BIDURA. Parish of Bidura, county of Caira, 40 miles north of Balranald. E.F.P. 94/108; R. 94/7. *Opal (doubtful).*

BIG BADJA RIVER. [*See* Umaralla.]

BIG BURRAWONG HILL. [*See* Bateman's Bay.]

BIG HOLE. South of Braidwood. O.T. 00/199, M.R. No. 25, 19/11, 218. *Limestone.*

BIG OAKEY CREEK. [*See* Wattle Flat.]

BILAMBIL CREEK. [*See* Murwillumbah.]

BILLABONG GOLDFIELD. [*See* Parkes.]

Billabong or Goobang Creek, M.P. 82/102; Rec. VI, pt. 4, 00/203, 230. *Gold.*

BILLAGOE. [*See* Mount Drysdale.]

BILLAPALOOLA OR BILLABALULAH. [*See* Tumut.]

BILLY'S LOOK-OUT. Parish of Coringle, county of Gipps, 6 miles south-west of Lake Cowal. R. 83/63, 94/23. *Gold.*

BIMBERAMALA CREEK. [*See* Bateman's Bay.] Parish of Currock, county of St. Vincent, 20 miles east of Braidwood. W.A. 89/233. *Gold.*

BIMBI. Bribaree Creek, parish of Bribaree, county of Bland, 25 miles north-west of Young. *Gold, Chromite.*

BIMBIMBIE. [*See* Bateman's Bay.]

BINALONG. Tangmangaroo, Kangiara, Boorowa Rivers, parishes of Eubindal, county of Harden and Taunton, county of King, 9 miles east of Binalong. J.E.C. M.R. No. 6, 08/272, 354. R. 03/44, 04/43, 90, 05/41, 06/42, 86, 07/46, 08/42, 09/43, 48, 10/43, 11/47, 53, 93, 12/43, 50, 13/46, 53, 14/47, 86, 15/24, 50, 16/21, 23, 43, 17/19, 38, 42, 18/39, 82. *Gold, Silver, Copper, Lead.*

R. 91/103, 02/46. *Silver.*

M.P. 82/107. *Iron.*

Digitized by Google

Parishes of Harden and Binalong, county of Harden, west of Binalong. J.E.C. M.R. No. 6, 08/270; R. 12/50, 13/53, 14/59. *Copper.*
R. 08/21, 09/21, 14/27. *Gold.*

Limestone Creek, Galong, parish of Bobbara, parish of Binalong, 7 to 9 miles north and north-west of Binalong. R. 12/72, 73; M.R. No. 25, 19/251. *Limestone.*

Boorowa Flat Creek, parish of Nurung, 10 miles north-west of Binalong. M.R. No. 25, 19/253. *Limestone.*

Mylora, parish of Mylora, between Bookham and Binalong. M.P. 82/108. Assay, 06/181. *Iron, Purple Oxide (pigment).*

BINDA. Parish of Julong, county of Georgiana, 36 miles north-west of Goulburn. J.E.C. M.R. No. 6, 08/54; R. 04/23.
Silver, Copper, with Gold.

BINGARA. [*See* Cope's Creek.]

Bingara and vicinity, Mount Derra Derra, &c., parishes of Bingara, Derra Derra, Mayo, Clare, Gum Flat, and Stag, county of Murchison. M.P. 82/122; W.A. 87/156, 88/179; G.A.S. 94/131; Rec. IV, pt. 2; E.F.P. 97/172; M.R. p. 69, 387; Rec. VI, pt. 4, 00/298, 299; R. 02/54, 03/52, 04/50, 13/59; also in parish of Bangheet, M.L. 132.
Gems, Diamonds.

Parish of Bingara. L.Y. 78/178; E.F.P. 81/142; Rec. VI, pt. 4, 00/190, 199, 200, 227. R. 95/28, 04/23, 06/20, 14/20, 15/20, 16/19, 17/16. *Gold.*
J.E.C. 97/169; M.R. No. 15, 12/50. *Wolfram.*

Spring Creek, near Sugarloaf, 1 to 14 miles from Bingara. E.F.P. 81/142; M.P. 82/100; J.E.C. M.R. No. 16, 12/26. *Antimony.*
Assay 07/175, 182. *Cobalt, Nickel.*
J.E.C. 97/149; M.R. No. 1, 1898; R. 02/131, 05/63, 06/58; 3 miles east, 8 miles north, 12 to 14 miles south of Bingara. Angula and Hall's Creeks, parish of Keira, 15 miles south-east of Bingara. J.E.C. 98/159; M.P. 82/114, 18/62. *Chromite.*

Bobby Whitlow, parish of Myall. L.Y. 78/178; J.E.C. M.R. No. 6, 08/317, 329; R. 76/71, 83/90, 00/56, 04/46, 05/46, 06/49, 07/55, 11/21, 14/23. *Copper, Gold.*

Bora Creek, &c., parish of Bingara, 7 to 8 miles from Bingara. J.E.C. M.R. No. 6, 08/317, 318; R. 98/70, 08/50. *Copper.*
R. 78/122, 05/17, 06/19, 07/22, 11/21. *Gold.*

Spring Creek, 3 to 7 miles south-east of Bingara; E.F.P. 81/142; W.A. 88/180; J.E.C. M.R. No. 6, 08/317, 326; R. 88/180, 99/69, 00/56, 01/55. *Gold, Silver, Copper.*
T.W.E.D. 91/234; J.E.C. M.R. No. 7, 2nd edition, 13/17, 26, 46; E.F.P. M.R. p. 277; R. 91/115. *Mercury.*

Bendover or Bengonover. M.P. 82/102, 122. C.S.W. 86/42. R. 03/52, 05/47. *Diamonds, Tin.*

Myall River, north and north-east of Bingara. *Tin.*

Horton River, parish of Rider, 16 miles west of Bingara. M.P. 82/114; Assay, 02/131. *Iron, Chromite.*

Myall Creek, parish of Molroy, 3 miles north of Bingara; Bobby Whitlow, parish of Myall, 5 miles to 7 miles north-east of Bingara; parish of Delingera, Borah Falls, parish of Gouron, 7 miles south-east; parish of Evans, 7 to 10 miles east; Spring Creek, parish of Bingara, 3 miles south-east. M.R. No. 25, 19/278, 279, 281.

Digitized by Google

Horton River, parish of Derra Derra, 10 miles west-south-west of Bingara; parish of Glass, 15 miles north-north-west; Rocky Creek Junction, parish of Eulowrie, 16 miles south-west of Bingara. M.P., 82/102; R. 07/61, 08/168; M.R. No. 25, 19/279, 280. *Limestone.*

Duck Holes Creek, Meogera Creek, parishes of Horton, Boomi, Pallal, and Lindsay, 9 miles south of Horton. M.R. No. 25, 19/280. *Limestone.*

BINGARA, TOP OR UPPER. Barrack Creek, parish of Dinoga, county of Murchison. R. 94/30, 95/28, 06/20, 07/22. *Gold.*

Parish of Hall. R. 82/81, 83/90, 88/181. *Gold.*

Gouron Gouron Creek. W.A. 88/181. *Gold.*

Mount Lauff, &c., parishes of Dinoga, Gouron, and Macintyre. J.E.C. M.R. No. 6, 08/326, 327; R. 99/69, 00/56, 01/55, 05/17, 46; 06/49, 07/55, 14/23, 15/20. *Copper.*

Mount Everest. R. 08/50, 09/50, 10/49, 14/55. *Iron, Copper.*

Ruby Hill, parish of Dinoga, 15 miles south of Bingara. E.F.P. 00/180; M.R. p. 392; R. 03/52. *Diamonds.*

Parish of Dinoga. R. 16/62. *Chromite.*

Piedmont, parish of Macintyre, 4 miles east of Upper Bingara. R. 15/63, 16/62, 18/63. *Magnesite.*

Between Bingara Falls and Red Rock, parish of Hall, 3½ miles south and 1½ miles north-north-west of Upper Bingara, parish of Macintyre, 2 miles east. J.E.C. and L.J.J. M.R. No. 25, 19/279. *Limestone.*

BINNI CREEK. [*See* Cowra.]

BIRGANBIL. [*See* Gulgong.]

BIRLONG. [*See* Armidale.]

BIRRAWA. [*See* Dunedoo.]

BISCHOFF. [*See* Coramba.]

BISCUIT CREEK. [*See* Guy Fawkes.]

BISMUTH. [*See* Torrington.]

BLACK BULLOCK MOUNT. [*See* Oberon.]

BLACK JACK MOUNTAIN. [*See* Delegate, Gunnedah, Peel River.]

BLACK JACK RANGE. [*See* Delegate.]

BLACKHEATH. [*See* Coal Index.]

BLACKMAN'S CROWN. [*See* Coal Index.]

BLACKMAN'S CREEK. [*See* Tuena.]

BLACKMAN'S SWAMP. [*See* Limekilns.]

BLACK MOUNTAIN. [*See* Rockley.]

BLACK MOUNTAIN RAILWAY STATION. Park Creek, parish of Exmouth, county of Sandon. E.F.P. 04/137. *Lignite.*

Greengate, 6½ miles south of station. E.C.A. 05/151. *Gold, Silver, Lead, Copper.*

BLACK MOUNTAIN. [*See* Barraba, Rockley, Wellington and Nuntherangie.]

Near Nuntherungie, county of Yungnulgra. J.E.C. M.R. No. 6, 99/54; R. 90/127. *Gold, Silver, Copper.*

BLACK RANGE. [*See* Albury, Bega, Bobadah, and Trundle.]

BLACK SPRINGS. [*See* Adelong, Nerrigundah, and Ophir.]

BLAIR HILL. [*See* Glen Innes.]

BLAKENEY'S CREEK. North-north-east of Yass. R. 83/76. *Gold.*

BLATCHFORD MOUNT. [*See* Mudgee.]

Digitized by Google

BLAYNEY. East and west of Blayney and west at Brown's Creek, parishes of Errol, Beaufort, &c., County of Bathurst. [*See* Forest Reefs.]
C.S.W. 81/131, 86/134; E.F.P. 81/139; M.R. p. 65; J.B.J. 93/120; M.P. 87/29; R. 95/17, 98/27, 05/13, 08/17, 09/16, 10/16, 13/17, 88, 14/19, 15/17, 176, 16/16, 17/14. *Gold.*
McPhillamy's Hill, Red Hill, King's Plains, parish of Torrens, 5 to 8 miles north-east of Blayney. C.S.W. 86/134; R. 75/59, 88/64, 94/20, 03/13, 05/13, 06/17, 08/17, 10/16, 11/18, 14/19, 15/17, 16/16. *Gold.*
R. 80/84. *Asbestos.*
Annandale, Brown's Creek, &c., parishes of Beaufort, Calvert, Lindsay, Napier, and Osborne, east, west, and south of Blayney. J.E.C. M.R. No. 6, 08/20, 106, &c.; M.P. 82/24, 26; R. 81/36, 82/37, 87/53, 89/135, 96/49, 98/27, 99/67, 00/54, 01/54, 82, 07/52, 08/47, 09/47, 12/48, 13/88, 15/49, 16/48, 17/41, 18/12. *Copper.*
Parish of Calvert, 9 miles south-west of Millthorpe. J.E.C. M.R. No. 6, 08/161. *Copper.*
Guyong, parish of Colville, 7 miles north of Blayney. J.E.C. M.R. No. 6, 08/141; R. 01/54, 02/49. *Copper.*
E.F.P. M.R. p. 385. *Diamonds.*
Back and Brown's Creeks, &c., parishes of Errol and Calvert. J.E.C. 92/148; Mem. G. 6, 08/147, 168, 234; J.B.J. Mem. G. 2, 01/61, 139; M.P. 82/28, 107; R. 83/37; Assay 83/38, 14/214. *Iron, Ochre.*
Parish of Napier, 8 miles north-east of Blayney. L.F.H. 05/152. *China Clay.*
Assay 16/220. *Manganese.*
Rec. VI, pt. 4, 00/34. *Mineral Waters.*
Brown's Creek, parishes of Calvert and Lindsay, 1 to 5 miles west and north-west of Blayney. J.E.C. 15/176; M R. No. 25, 19/176, 179; R. 15/57. *Limestone.*

BLETCHINGTON. [*See* Lucknow under Orange.]

BLICKS RIVER. 20 miles north-west of Dorrigo. *Gold.*

BLIND CREEK. [*See* Murrumburrah under Harden.]

BLOOMFIELD. [*See* Yass.]

BLOSSOM HILL. [*See* Rockley.]

BLUE CREEK. [*See* Yarrangobilly.]

BLUE MOUNTAIN CREEK. [*See* Walcha.]

BLUE ROCK. [*See* Capertee.]

BLUNDELL MOUNT. [*See* Coree.]

BOBADAH (late Overflow) or Carpina, Black Range, parish of Cameron, county of Flinders, 30 miles east of Nymagee. R. 95/30, 84, 96/70, 97/50, 13/12, 16/11. *Gold.*
J.E.C. M.R. No. 6, 08/194, 261; R. 98/69, 99/07, 00/52, 08/45, 10/44, 97, 11/48, 89, 12/11, 44, 48, 13/47, 51, 105, 14/12, 48, 52, 101. *Copper, Gold, Silver, Lead.*
Hillman's Tank, parish of Wicklow, county of Cunningham, 4 miles south-west of Bobadah. J.E.C. M.R. No. 6, 08/194. *Copper* (poor).
Parish of Walker's Hill, county of Flinders, 12 miles south-east of Bobadah. J.E.C. M.R. No. 6, 08/262. *Copper* (poor).
Parish of Nangerybone, 7 miles south-west of Bobadah. J.E.C. M.R. No. 6, 08/280. *Copper, Silver, Gold* (trace).
J.E.C. 97/171; M.R. No.15, 12/62; E.F.P. M.R. p. 302; L.J.J. 17/170. *Tungsten.*

Digitized by Google

BOBBIWA. Parish of Bobbiwa, county of Jamieson, 25 miles north-east of Narrabri. R. 90/110, 91/121. *Gold.*

BOBBY WHITLOW. [*See* Bingara.]

BOBO RIVER. 12 miles west of Nana, county of Fitzroy. R. 07/23, 08/20, 09/20. *Gold.*

BOB'S CREEK. [*See* Sunny Corner.]

BOB'S MOUNT. [*See* Orange.]

BOCOBLE. [*See* Cudgegong, Manildra, and Molong.]

BODALLA. Parish of Bodalla, county of Dampier. E.F.P. M.R. p. 409; Rec. IV, pt. 1, p. 20. *Turquoise.*

BODANGORA (Mitchell's Creek). Bodangora and Daviesville, county of Lincoln, 7½ miles north-east of Wellington. Jaw Bone, Nanima, parish of Nanima, county of Bligh, 4½ miles north-north-east of Wellington.

E.F.P. 00/175.

R. 75/71, 90/14, 71, 135, 91/80, 92/18, 93/20, 95/19, 87, 98/32, 99/26, 01/83, 02/22, 03/19, 04/20, 05/15, 06/18, 07/21, 08/19, 09/18, 10/19, 11/20, 12/18, 82, 13/20, 87, 14/21, 86, 15/19, 86, 16/18, 17/16, 18/14. Bores 18/74. *Gold, with Silver, Lead, Copper.*

Parish of Tenandra, county of Lincoln, 11 miles north of Wellington. [*See* Wellington.]

J.E.C. M.R. No. 6, 08/291; R. 75/31. *Copper.*

Spicer's Creek, parish of Mitchell, county of Lincoln, 5 miles north-east of Bodangora. R. 78/70. *Gold.*

Parish of Bodangora, county of Lincoln, ½ mile east of Bodangora. J.E.C. and L.J.J. M.R. No. 25, 19/264. *Limestone.*

BOG. Quinburra Bog, parish of Lawson, county of Wellesley, 8½ miles south-east of Delegate. J.E.C. 96/101. *Gold.*

BOGABRI. Parish of Bogabri, county of Pottinger.

E.C. Saint Smith, 11/190; R. 10/59, 11/66, 16/63; Assay, 16/224. *Fuller's Earth.*

M.R. No. 25, 19/310. *Limestone.*

Assay, 07/180. *Iron.*

13/189. *Magnesite.*

BOGGY CREEK. [*See* Tumbarumba and Walcha.]

BOGGY CAMP. [*See* Copeton.]

BOGONG MOUNTAIN. 16 miles south-east of Tumut, county of Buccleuch. R. 04/47, 15/85. *Copper (Bornite).*

BOGONG and Grey Mares, Bogong, parish of Jagungal, county of Selwyn, 24 miles south-south-west of Kiandra. J.E.C. 95/131; R. 97/12, 02/28. *Gold.*

BOIGA CREEK. [*See* Pyramul.]

BOLAGAMY. [*See* Yalgogrin.]

BOLDERODGERY. [*See* Yeoval.]

BOLIVIA. Splitters' Creek, Bolivia Creek, Deepwater River, north and north-west of Mount Capoompeta, parishes of Angoperran, Bolivia, and Booroo, county of Clive, west, south, and south-east of railway station.

E.C.A. M.R. No. 24, 16/31, 63, 70; R. 16/59, 17/86, 18/53; J.E.C. and E.C.A. 18/154. *Bismuth, Molybdenite.*

Digitized by Google

Parish of Bolivia, E.F.P. M.R. p. 298; E.C.A. 01/170; R. 01/65, 14/88. *Wolfram.*

Parishes of Bolivia and Farnell. J.E.C. M.R. No. 6, 99/55; M.R. No. 14, 11/292; E.C.A. 01/170; R. 99/72, 13/48. *Silver, Copper, Tin.*

Five Bull Creek. R. 97/48. *Gold.*

BOLOWRA CREEK. County of St. Vincent, 12 miles north of Brimbramalla Creek. R. 05/21. *Gold.*

BOMBOWLEE, or Bumbolee. [*See* Tumut.]

BOMBAH. [*See* Trunkey.]

BOMBALA. Parish of Bombala, county of Wellesley. J.E.C. M.R. No. 6, 99/55; R. 86/72. *Copper* (poor).

Parish of Burrumbucco, 10 miles south-east of Bombala. *Gold.*

20 miles west of Bombala. J.A.W. M.R. No. 4, 98/4. *Bismuth.*

Tingey's Plains, Rocky Hill, Coolangubra, parish of Burrimbucco, county of Wellesley, and parish of Coolangubra, county of Auckland, 13 miles south-east of Bombala.

J.E.C. 96/125; R. 96/34, 98/45. *Gold.*

Slaughter House Creek, Delegate River, parishes of Merriangah and Quidong, county of Wellesley, 12 miles north of Bombala. [*See* Delegate]. J.E.C. and L.J.J. M.R. No. 25, 19/328. *Limestone.*

Badgery's Swamp, parish of Cathcart, south of Harper's C.P. 189, 15 miles north-east of Bombala. *Gems.*

Beresford. R. 06/52. *Tin* (poor).

Bibbenluke, Bombala Creek, north of Bombala. R. 90/82. *Tin and Gold* (poor).

BOMBALA RIVER. [*See* Nimmitabel.]

BOMBAY CREEK. [*See* Braidwood.]

BONADA REEFS. [*See* Stuart Town.]

BONDI. Towamba Gold Field, county Auckland, Victorian Border.

BONEY'S ROCKS. [*See* Cargo.]

BONGONGALONG. [*See* Gundagai.]

BONLEY GOLD FIELD. 37 miles south-west of Wilcannia. R. 00/34. *Gold.*

BONSHAW. Parish of Bonshaw, county of Arrawatta. J.E.C. M.R. No. 6, 99/55. *Antimony, Copper.*

BOOKHAM. Parish of Bookham, county of Harden, 12 miles south-west of Bowning. J.B.J. Mem. G. 2, 01/146. *Iron.*

J.E.C. M.R. No. 6, 99/56. *Copper.*

8 miles south-east of Bookham; Assay 03/141. *Manganese.*

Parish of Talmo, 7 miles south of Bookham. M.R. No. 25, 19/253. *Limestone.*

BOOKOOKOORARA. [*See* Undercliff.]

BOOLBIE MOUNT. [*See* Coolongolook.]

BOONA. [*See* Melrose.]

BOONOO BOONOO. Basket and Dismal Swamps, &c., parish of Boonoo Boonoo, county of Buller; parish of Barney Downs, county of Clive.

C.S.W. 89/199.

R. 75/57, 88/111, 98/52, 68, 09/20, 11/23, 12/20, 15/20; Dredge 11/30, &c., 16/20. *Silver, Gold, Copper.*

M.P. 82/102; Dredge 04/30. *Tin.*

Digitized by Google

Boorolong. Parish of Boorolong, county of Sandon, 17 miles north-west of Armidale.

R. 99/72, 00/59, 06/181. *Tin.*

J.E.C. M.R. No. 6, 99/56. *Copper.*

M.P. 82/100; J.E.C. M.R. No. 16, 12/3. *Antimony.*

Parish of Sandy Creek, county of Hardinge, 28 miles north-west of Armidale. [*See* Bundarra].

E.C.A. M.R. No. 24, 16/71; R. 14/88. *Molybdenite.*

Boorook. Kimberley, &c., Cataract River, parish of Boorook, county Buller, 12 miles north-west of Drake.

E.F.P. M.R., p. 90; E.C.A. M.R. No. 12, 08/38; M.P. 82/30, 86, 88.

R. 78/35, 91, 79/157, 162, 80/45, 215, 236, 83/108, 01/31, 04/21, 06/43, 07/47, 17/39. *Silver, Gold, &c.*

Kangaroo and Girard's Creeks, parish of Antimony. R. 09/20, 10/21. *Gold.*

Boorowa. [*See* Binalong.] Grassy Creek and Municipality, R. 91/103, 14/25. *Gold.*

Goba, parish of Congera, county of Monteagle, 9 miles north of Boorowa.

Narrallen, Right Hand and Narraba Creeks, parishes of Narrallen and Yundoo. Near Kenyu, 14 to 17 miles north of Boorowa.

J.B.J. 98/172; J.E.C. M.R. No. 6, 08/351, 352, 366; R. 79/189, 91/103 *Gold, Copper.*

M.P. 82/109. *Tin.*

Lamp Creek. R. 07/24. *Gold.*

Rye Park, parishes of Olney and Opton, county of King, 18 miles south-east of Boorowa. J.E.C. M.R. No. 6, 08/335, 362.

R. 95, 61, 96/49, 01/51, 16/49. Assay 14/214. *Copper, Silver, Lead, Zinc.*

R. 15/85; L.F.H. 17/167; R. 18/60. *Wolfram.*

Parish of Rugby, county of King. R. 16/21. *Gold.*

Pudman's Creek, Wallah Wallah, parishes of Rugby and Ware, 10 to 15 miles east of Boorowa. J.E.C. M.R. No. 6, 08/272, 365, 368; R. 18/39. *Copper.*

Parishes of Blakeney, Olney, Opton, and Ware, 20 miles east of Boorowa. W.A. 91/259; E.F.P. M.R. p. 117. R. 89/81, 86, 91/103, 96/47, 99/64, 00/52, 01/51, 04/43, 05/41, 06/42, 07/46, 09/43, 10/43, 15/22, 45, 16/43, 17/38, 18/37. *Silver.*

Frogmore or Frogmoor, por. 180, parish of Alton, county of King, 20 miles north-north-east of Boorowa. W.A. 91/259; J.E.C. M.R. No. 6, 08/345, &c.,; R. 81/109, 82/60, 91/103, 99/68, 00/56, 07/54, 13/53, 14/54, 18/40. *Copper, with traces of Gold and Silver.*

Near Copper Mine. R. 79/189, 94/24, 02/27, 04/16, 06/42. *Gold.*

J.E.C. 97/169; M.R. No. 15, 12/52, 56, 81; E.F.P. M.R. p. 298; L.F.H. 19/; R. 14/66, 86, 15/61, 81, 16/61, 17/54. *Tungsten, Sheelite, Wolfram.*

R. 07/181; J.E.C. and L.J.J. M.R. No. 25, 19/259. *Limestone.*

Reid's Flat. R. 17/54, 18/82. *Wolfram.*

Lang's Creek, parish of Taunton, county of King, 5 miles south-east of Boorowa. J.E.C. M.R. No. 6, 08/360; R. 83/76, 05/45; parish of Boorowa, 18/40. *Copper* (poor).

Digitized by Google

Rye Park, parish of Ware, county of King, 10 miles north-east of Boorowa; parish of Barnett, 13 miles north-east; parish of Bala, 11 miles north-east. M.R. No. 25, 19/259, 260. *Limestone.*

Limestone Creek, Narrallen Creek, parishes of Narrallen, Yundo and Congera, county of Monteagle, 9 to 14 miles north-north-west of Boorowa.

Limestone Waterholes, head of Davey's Creek, parish of Congewalla, county of Monteagle, 9 miles north-west of Boorowa. M.R. No. 25, 19/276, 277. *Limestone.*

BOOTHERAGANDRA. Parish of Bootheragandra, county of Nicholson, 20 miles east of Hillston. R. 13/12, 14/12. *Gold.*

BOPPY MOUNT. [*See* Canbelego.]

BORA CREEK. [*See* Bingara.] Bora and Postman's Creeks, Mihi, and Melrose (Enmore); parishes of Enmore and Merrigalah, county of Sandon. R. 76/103, 78/120, 89/97, 98, 93/61, 95/27, 99/41, 07/21, 08/19, 10/20, 13/21, 14/22, 88, 15/20. *Gold.*

BORAH CREEK. [*See* Howell.]

BORAH FALLS. [*See* Bingara.]

BORANEL CREEK. [*See* Copeland.]

BOREE CREEK and BORENORE. [*See* Cudal and Molong.]

BORO.

Parish of Barnet, county of Murray, 10½ miles south-south-east of Tarago. L.F.H. 15/187; R. 16/54, 17/47. *Tin.*

Parishes of Mulwaree and Boro, county of Argyle, 6 miles south-east of Tarago. E.F.P. M.R. p. 116, Rec. VI, pt. 4, 00/195; R. 05/41, 06/84, 07/46, 14/54. *Gold, Silver.*

M.P. 82/108, 113, 117; Assay 79/47. *Manganese, Iron.*

Boro Creek, parish of Barnet, county of Murray. M.R. No. 25, 19/282. *Limestone.*

BOTFIELD. [*See* Trundle.]

BOTOBOLAR. Parish of Botobolar, county of Phillip, 15 miles north-east of Mudgee. E.C.A. M.R. No. 21, 16/73. *Molybdenite Flakes.*

BOUNDARY CREEK. [*See* Wunglebong.]

BOURIMBLA CREEK.

BOURKE. Bald Hill, Mount Dijoe, parishes of Kaiwilta and Dijoe, county of Cooper, 30 miles west and north-west of Byrock. M.R. No. 6, 99/49; R. 91/141, 95/86, 04/14, 05/13, 06/11, 07/13, 09/108. *Copper, Gold.*

Parish of Mulholland, county of Cooper, 30 miles south-east of Bourke. R. 14/12. *Gold.*

BOURKE'S CREEK. [*See* Pulletop.]

BOX CREEK. [*See* Deepwater.]

BOWENFELS. County of Cook, 1 mile from Bowenfels. C.S.W. 75/129; J.E.C. 92/148; Mem. G. 6, 08/234. *Iron.*

Eskroy Estate, Newbold Co.; near Marrangaroo. R. 09/60, 10/59, 18/64; A. 15/195. *Quartzite mined for silica bricks.*

BOWLING ALLEY POINT. [*See* Nundle.]

BOWMAN RIVER. [*See* Copeland.]

BOWNING. Parish of Illalong, county of Harden, north-north-east from Goondah railway station. J.E.C. M.R. No. 6, 08/367. *Copper.*

M.P. 82/118. *Wad.*

Between Bowning and Bookham. *Iron.*

Digitized by Google

BOWRA. [*See* Nambucca.]
Parish of Missibotti, county of Raleigh, north-west and south-west of Bowra, 8 miles west of Nambucca, parish of Medlow; 22 miles south-west of Nambucca. C.S.W. 89/204; J.E.C. M.R. No. 16, 12/26; R. 88/224. *Antimony.*

BOWRAVILLE. [*See* Nambucca.]
West of Nambucca Heads. R. 98/46, 99/74, 07/81, 176. *Antimony.*
Assay 06/181. *Pigments.*
Purgatory Creek. R. 99/74. *Antimony.*

BOXERS' CREEK. [*See* Goulburn.]

BOX RIDGE (Turondale). [*See* Sofala and Tuena.]

BOYD or LITTLE RIVER. Parish of Marara, county of Gresham, south of Buccarumbi. Assay 06/178. *Barytes.*
Parishes of Springbrook and Nullama, near Dalmorton. Rec. VI, pt. 4, 00/201. R. 10/21. *Gold.*

BRAIDWOOD. Parishes of Braidwood, &c., county of St. Vincent. M.P. 82/24; W.A. 92/121; E.F.P. 02/121; J.B.J. 02/125; Rec. VI, pt. 4, 00/214; R. 96/11, 06/21, 84, 08/21, 11/24, 12/21, 13/24. Dredge 02/30, 09/25, &c., to 17/21. *Gold.*
Bell's Creek, parish of Seymour. R. 75/47, 96/11, 18/16. *Gold.*
Assay 16/219. Parish of Jinglemoney. R. 17/55. *Barytes.*
Jinglemoney. R. 79/116. *Silver, Gold.*
Currowan Creek, Sugarloaf, parish of Murrenburg, 11 miles east-south-east of Braidwood. J.E.C. M.R. No. 6, 08/336. *Copper.*
Monga, 3 miles east of Nelligan road, 10 miles south-east of Braidwood. *Copper.*
Green Creek. Thames Gully. J.E.C. M.R. No. 6, 08/335. *Copper and Silver.*
Kangaroo Flat, 4 miles west of Marlowe, 17 miles north of Braidwood. R. 96/11. *Gold.*
Dargues Reef. R. 14/84, 15/83. *Gold.*
Warrambucca, Warrambooka Creek, 6 miles east-south-east of Braidwood. R. 05/21, 78. *Gold.*
Bombay Creek, Shoalhaven River, parish of Jinglemoney, county of Murray, south-west of Braidwood. J.E.C. M.R. No. 6, 08/336; R. 07/54 *Copper.*
R. 79/116 *Gold.*
Warri, Shoalhaven River, parish of Warri, 8 miles north-west of Braidwood. R. 75/44, 81. Dredge 09/25, 10/25, 11/28, 13/28. *Gold.*
Britten's Hill, Currowan. Parish of Currowan, county of St. Vincent, 20 miles east-south-east of Braidwood. *Gold.*
Parishes of Marlowe and Larbert, county of St. Vincent, 13 miles north of Braidwood. J.E.C. and L.J.J. M.R. No. 25, 19/290, 327. *Limestone.*

BRANGA PARK. Parish of Branga, county of Vernon, 20 miles south of Walcha. R. 05/77. *Gold.*

BRASS KNOCKER CREEK. [*See* Bermaguee.]

BRASSINGTON CREEK. Parish of Bluff Land, county of Clive, 12 miles south of Tenterfield. R. 89/117, 15/53. *Tin.*

BRAWLIN. County of Harden, south-east of Cootamundra. J.E.C. 97/149; M.R. No. 1, 1898. *Chromite.*

BREAKFAST CREEK. [*See* O'Connell and Wiseman's Creek.]

Digitized by Google

BREADALBANE. Parishes of Mutmutbilly and Milbang, county of Argyle, between Cullerin and Breadalbane stations. J.B.J. Mem. G. 2, 01/119; J.E.C. M.R. No. 6, 08/339; E.F.P. Iron Ore deposits of N.S.W., 1910. R. 06/48, 07/54, 09/48, 11/94, 12/50, 13/53, 16/49, 17/42, 18/48, 79. *Copper, Iron, with gold and silver.*

Herffernan's Creek, Merrlla, parish of Gurrunda, 8 to 10 miles north of Breadalbane. J.E.C. M.R. No. 6, 08/338, &c.; R. 06/48, 84, 07/54, 08/48, 09/48, 10/48, 11/53, 12/54, 13/53, 14/52, 15/50, 16/49, 17/42, 18/39. *Copper, Barytes.*

Merrilla and 3 miles west, parish of Gurrunda, 15 miles west of Goulburn. J.E.C. Mem. G. 6, 08/233.

Assay 07/181. M.R. No. 25, 19/8, 138. *Limestone.*

BREDBO. Parish of Bransby, county of Beresford, 1 to 4 miles east of Bredbo. J.E.C. M.R. No. 6, 08/376, 377; R. 86/74, 88/97, 08/42. *Copper, Silver, Gold* (trace.)

Parishes of Bransby and Abercrombie. M.R. No. 25, 19/186. *Limestone.*

Cowra Creek, Bredbo River, parishes of Abercrombie and Stannard; Macanally and Fiery Creeks, Umaralla River, parish of Rose Valley, 8 miles east to 12 miles south-east of Bredbo. R. 89/91, 91/92, 95/23, 97/38, 10/15, 11/15, 12/14, 13/15, 14/16. *Gold.*

J.E.C. M.R. No. 6, 08/378. *Copper.*

Gungoandra, north of Bredbo. J.E.C. M.R. No. 6, 08/389 *Copper.*

Cappanana and Gungoandra Creeks, Murrumbidgee River, parishes of Abercrombie, Bransby and Gungoandra, 2 to 4 miles north-east to 4 miles south-east of Bredbo. *Limestone.*

BREEZA. 6 miles west, parish of Breeza, county of Pottinger. M.R. No. 25, 19/310. *Limestone*

BREWONGLE. [*See* Yetholme.]

BRIAR PARK. Dog Rocks. [*See* Oberon and Rockley.]

BRIBAREE CREEK. [*See* Bimbi.]

BRIMBRAMALLA or Bimberamala. [*See* Batemans Bay.]

BRINDABELLA. Goodradigbee River, parish of Brindabella, county of Cowley, 30 miles west of Queanbeyan. Rec. VI, pt. 4, 00/199. R. 88/94, 14/84. *Gold.*

BRIMS CREEK. [*See* Nowendoc.]

BRINGELLET. [*See* Rockley.]

BRISBANE VALLEY CREEK. [*See* Oberon.]

BRITTENS HILL. [*See* Braidwood.]

BROCKLEHURST. Parish of Terramungamine, county of Lincoln, 5 miles north of Dubbo. R. 12/62 *Ochre.*

BROGAN'S CREEK. Parishes of Tabrabucca and Warrangunnia, north-west of Brogan's Creek; McDonald's Hole, parish of Clandulla, county of Roxburgh, north and south-east of railway station.

J.E.C. G. 3, 03/124; M.R. No. 6, 08/246.; M.R. No. 25, 19/313, 314. *Limestone.*

BROGO RIVER. Near Bega, county of Auckland. Rec. VI, pt. 4 00/197; R. 14/84. *Copper.*

Robinson's Hole, Brogo River, parish of Mokoreeka, county of Auckland, 21 miles north-west of Bega.

Clarke's Southern Gold Fields of N.S.W., p. 154. R. 91/94 *Gold.*

Digitized by Google

Brogers Creek. Parish of Wallaya, county of Camden. J.B.J. Mem. G. 2, 01/54. *Iron.*

Broken Bago Range. [*See* Wauchope.]

Broken Creek. [*See* Nerrimungah.]

Broken Dam. [*See* Broken Hill and Nuntherungie.]

Broken Hill (Willyama and Barrier Range). County of Yancowinna. [*See* Barrier Range.]

Comprehensive reports on Broken Hill, Barrier Ranges, Silverton, Umberumberka, &c. Leg. Ass. papers, N.S.W., 1076A, 1883–4. W.H.J.S. 86/101; R. 86/101. Jour Roy. Soc., N.S.W., 1890, XXIV, 2, p. 177. E.F.P. 92/108; Rec. III, pt. 2, 1892. M.R., p. 246; J.B.J. 05/61; Mem. G. 5, 1894; Rec. VI, pt. 4, 00/328. D. Mawson, Roy. Soc., S.A., 1912, II, pt. 4. Trans. Aust. Inst. Mining Engineers, 1911, pt. 1, p. 161; J.E.C. 18/157; M.R. No. 6, 08/17, &c., R. L. Jack Parliamentary Paper, Queensland, 1891, R. 03/41, 06/38. *Silver, Lead, Zinc, Copper.*

R. 84/107, 85/101, 86/101, 87/104, 88/121, 89/123, 90/125, 91/137, 92/39, 93/40, 94/49, 95/54; 96/46, 97/60, 98/67, 99/63, 00/51, 97, 99, 01/49, 79, 81, 02/44, 69, 03/41, 68, 04/30, 80, 05/36, 81, 06/36, 37, 56, 88, 07/41, 83, 08/38, 89, 09/39, 95, 10/40, 86, 11/43, 94, 12/41, 84, 13/43, 91, 14/44, 89, 15/41, 87, 16/40, 88, 17/35, 79, 82, 18/33, 84. *Silver, &c.*

Silverton, parishes of Bray and Umberumberka, 15 miles north-west of Broken Hill. E.F.P. M.R. p. 93; J.B.J. Mem. G. 5, 94/116.

R. 84/107, 85/101, 86/101, 87/104, 88/121, 89/123, 90/125, 91/137, 92/39, 93/40, 94/49, 95/54, 96/46, 97/60, 98/67, 99/63. *Silver.*

J.E.C. M.R. No. 6, 08/90, 99, 102, 104; R. 02/72, 11/95. *Copper.*

Umberumberka, north of Silverton. C.S.W. 87/143. *Silver.*

Appolyon Valley. R. 12/91, 13/97. [*See* Purnamoota.] *Copper.*

Balaclava, The Pinnacles, &c. E.F.P. M.R., p. 99, 199, 02/121; J.B.J. 02/126, 05/61; Rec. VII, pt. 1, 00/20.

R. 83/126, 93/45, 98/101, 03/41, 08/46, 11/99, 14/85, 15/51. *Ironstone, Copper, Silver.*

Broken Dam, Boomerang Hill, Hornsby Range, 22 to 30 miles north-north-east of Broken Hill.

Rockwell, parish of Sebastopol, 9 miles south-east of Broken Hill. J.E.C. M.R. No. 6, 08/95, 100, 103. *Copper.*

Mulga Springs, parish of Moorkaie, 12 miles east-north-east of Broken Hill. J.E.C. M.R. No. 6, 08/91. *Copper.*

12 miles north-east of Mount Gipps. J.E.C. M.R. No. 6, 08/91. *Copper.*

Razorback Range, parish of Moorkaie, 12 miles north-east of Broken Hill. J.B.J. G. 5, 94/135. *Iron.*

Mount Gipps, parish of Mount Gipps, 13 miles north of Broken Hill. J.A.W. M.R. No. 4, 1898; E.F.P. M.R., p. 267. *Bismuth.*

Little Darling Springs, near Darling Creek, parish of Tara, 10 miles east-north-east of Broken Hill. J.B.J. Mem. G. 5, 94/134. *Platinum, Bismuth.*

Mulga Springs, parishes of Moorkaie and Tara. C.S.W. 89/208. J.C.H.M., 91/276, Jour. Roy. Soc., N.S.W., XIII, 1889, p. 326, 1892, p. 371; J.B.J. 92/143; Rec. V, pt. 1, 1896; E.F.P. M.R. p. 80.

Digitized by Google

R. 92/142, 06/181, 07/175, 182. **Assay**, 16/225. *Platinum, Palladium.*

Broken Hill Consols Mine, east of Broken Hill. J.B.J. Mem. G. 5, 94/123; J.E.C. M.R. No. 16, 12/27; E.F.P. M.R., p. 246. *Antimonial Silver with Zinc.*

E.F.P. 93/106; M.R., p. 99, 223; Rec. IV, pt. 1, 94/21; E.C.A. M.R. No. 11, 1906; Assay 06/180, 07/175. *Cobalt, Nickel, Willyamite, Wulfernite.*

Broken Hill District Rec. No. 1, 96/8; J.E.C. M.R. No. 15, 12/89; R. 93/49. *Wolfram, Stokite.*

M.P. 87/43; J.E.C. M.R. No. 7, 00/10. *Mercury.*

Yanco Glen, parish of Wankeroo, county of Yancowinna, 20 miles north-north-west of Broken Hill at 27 miles from Broken Hill at Thompson's siding. R. 18/86. *Wolfram.*

Rockwell, parish of Sebastopol, 9 miles south-east of Broken Hill. J.B.J. G. 5, 94/134; E.F.P. M.R., p. 423; R. 11/52. *Asbestos.*

Yanco Glen. R. 04/56, 05/55. *Gypsum.*

Lakes Grave C.R., parish of Umberumberka, J.B.J. Mem. G. 5, 94/45.

Acacia Dam, parish of Naradin. R. 89/123, 98/101. *Limestone* [*See Corona.*]

Parishes of Nambuck, Bray, Alma, Umberumberka, &c. M.R. No. 25, 19/351, 352. *Dolomitic Amorphous and Nodular Limestone.*

BROMAN. Broomen or Burroman, Clyde River, 14 miles north of Nelligen, county of St. Vincent. R. 87/76, 05/21. *Gold.*

BROOMBEE. [*See* Mudgee.]

BROOKS' CREEK. [*See* Bywong.]

BROOKVALE. Near Manly. M.M. 18/161. *Ball Clay.*

BROTHERS, MT. [*See* Lewis Ponds.]

BROTHERS, THE. [*See* Inverell.]

BROUGHTON VALE. [*See* Coal Index.]

BROULA RANGE. [*See* Cowra and Grenfell.]

BROULEE. [*See* Moruya.]

BROWNLEA. [*See* Back Creek, Rockley.]

BROWN, MT. [*See* Milparinka.]

BROWN'S CREEK. [*See* Blayney and Carcoar.]

BROWN'S CAMP. Parish of Currowang, county of Wellesley, near Victorian Border. J.E.C. 97/161; R. 95/23, 07/25, 09/23. *Gold.*

BRUISER'S CREEK. South of Newton Boyd. *Gold.*

BRUNGLE CREEK. [*See* Tumut.]

BRUNT'S CREEK. [*See* Rydal.]

BUCCA CREEK. Bugga or Bucka Creeks. [*See* Coramba.]

BUCCRA BENDINNI CREEK. [*See* Taylor's Arm.]

BUCKAROO. [*See* Mudgee.]

BUCKEEN CREEK. [*See* Holbrook.]

BUCKINBAH. [*See* Yeoval.]

BUCKLEY'S CROSSING. [*See* Dalgety.]

BUCKLE, MT. Parish of Waalumna, county of Auckland, 24 miles west-north-west of Cape Howe; J.E.C. 96/101, 97/156. *Gold.*

BUDAWANG RANGE. [*See* Mongarlowe.]

BUDDIGOWER. [*See* Wyalong.]

BUDGEE BUDGEE. [*See* Mudgee.]

BUDGERY AND BUDGERYGAR. [*See* Hermidale.]

BULBIE, MT. [*See* Taree.]

Digitized by Google

BULGA, MT. [*See* Gundagai and Orange.

BULGA SWAMP. Near Stuart Town. *Gold.*

BULGANDRY. Walbundry, parish of Bulgandry, counties of Hume and Urana, 36 miles north-north-west of Albury. E.F.P. 95/117; R. 95/83, 96/30, 99/32, 00/25, 01/25. *Gold.*

BULLABOOLA, MT. County of Pottinger. *Gems.*

BULLAH DELAH. Parish of Boolombayt, county of Gloucester. Advisory Council of Science and Industry, Commonwealth of Australia, Bulletin No. 3, 1917. E.F.P. M.R. p. 415; R. 90/114, 91/129, 92/51, 98/78, 00/64, 01/66, 02/58, 03/56, 06/60, 07/65, 08/60, 09/59, 10/58, 11/64, 12/61, 13/66, 14/66, 15/62, 16/61, 17/54, 18/61. *Alum.*

Red Hill, Paddy's Creek, parish of Topi Topi. *Gold.*

Bungwall, Myall Lake. R. 90/114. M.R. No. 25, 19/241. *Limestone.*

BULLAWA CREEK. Parish of Bullawa, county of Nandewar, 10 miles north-east of Narrabri. E.F.P. 02/119; R. 90/110. *Gold, Diamonds.*

BULL CREEK. [*See* Nambucca.]

BULL DOG. Solferino and Sunny Corner. *Gold, Silver.*

BULLI. [*See* Coal Index.]

Parish of Southend, county of Cumberland. J.B.J. Mem. G. 2, 01/53, 113; M.P. 82/113. *Iron.*

BULLIO. Parish of Bullio, county of Camden. J.E.C. M.R. No. 6, 08/336. R. 06/48. *Copper, Silver, Gold* (trace).

J.B.J. Mem. G. 2, 01/61; Parish of Bangadilly. *Iron.*

BULL'S CREEK. [*See* Jenolan.]

BUMBALDRY. [*See* Grenfell.]

BUMBERRY. Reedy Creek, parish of Terarra, county of Ashburnham, 9 miles south-east of Bumberry. J.E.C. M.R. No. 6, 08/18, 271, 282; R. 98/33, 00/55, 11/52, 12/49. *Copper.*

BUMBO. [*See* Noorooma.]

BUMBOLEE CREEK. [*See* Tumut.]

BUNBEJONG. E.F.P. M.R. p. 40. *Sapphires.*

BUNDANOON. [*See* Coal Index.]

Bundanoon Creek, near Kangaroo River. *Gold.*

BUNDARRA. Gwydir River, parish of Darbysleigh, county of Hardinge, 3 miles south of Bundarra. J.B.J. 97/175; J.E.C. M.R. No. 6, 08/318; R. 03/140, 05/46, 06/49, 96, 07/55, 08/50, 09/50. *Copper.*

J.E.C. 97/169; M.R. No. 15, 12/52; E.F.P. M.R. p. 298. *Wolfram.*

Moredun Clerk's Creek, parish of Bundarra, M.P. 82/102. *Tin.*

Laura Creek, parishes of Abington and Russell, 14 miles south-east of Bundarra, west of Boorolong; E.C.A. M.R. No. 24, 16/118. *Molybdenite.*

BUNDUNDAH CREEK. [*See* Yalwal.]

BUNGALLA. [*See* Tenterfield.]

BUNGAMBRAWATHA CREEK. 3 miles north of Albury. *Gold.*

BUNGIEBOMAR. Parish of Bungiebomar, county of Lincoln, 20 miles north-east of Wellington. J.E.C. M.R. No. 6, 08/289; L.J.J. 18/163. *Copper.*

Digitized by Google

BUNGENDORE. Parish of Majura, county of Murray, 5 miles south of Bungendore. R. 03/27. *Gold.*
M.P. 82/118; R. 80/125. *Manganese, Wad.*
R. 14/84. *Copper.*
Lomolong, 6 miles from Bungendore. R. 13/58. *Tin.*
Reedy Creek, parishes of Fairy Meadow and Barnet, 12 miles north-east of Bungendore. R. 14/59, 15/54; Woodlands, R. 18/11. *Tin, Gold.*
R. 17/38. *Silver.*
Fairy Meadow, parishes of Fairy Meadow, Merigan, and Mulloon, 8 to 10 miles east and north-east of Bungendore. Parish of Majura, 4½ miles south-west. M.R. No. 25, 19/285, 291, 292. *Limestone.*
Parish of Fairy Meadow. P.M.L. 1; R. 17/42. *Copper.*

BUNGONIA. Parish of Inverary, county of Argyle, 3 miles south of junction Bungonia Creek and Shoalhaven River, Cryer's Arm and Spring Creeks, Jasper's Gully, parishes of Jerralong and Nerrimunga, 10 to 15 miles south-east of Bungonia.
Parish of Yarralaw, Jacqua and Nerrimunga Creek junction. M.P. 82/103; J.E.C. M.R. No. 6, 08/337, 353, 354; Rec. VI, pt. 4, 00/195; R. 75/88, 89, 08/20, 10/48, 12/54, 13/23, 14/24, 15/22, 18/17. *Copper, Silver, Lead, Gold.*
Tin Gully, Spring Creek. J.E.C. M.R. No. 14, 11/283; R. 04/49, 13/46, 14/47, 59, 15/44, 16/43, 17/38. *Silver, Lead, Tin.*
Still Creek, parish of Inverary, 2½ miles west-north-west of junction Shoalhaven and Nerrimunga Creeks, Spa Creek, 2 miles south of Nerrimunga. Paddy's River 7 to 13 miles south-east of Bungonia. Rec. VI, pt. 4, 00/207; R. 75/88, 79/116, 81/59, 97/12, 09/21, 10/22 11/24, 12/21, 17/18. *Gold.*
Jaqua Creek, Dog Trap, &c. Parish of Bungonia, &c. Clarke's Southern Gold Fields of N.S.W. M.P. 82/113; J.B.J. Mem. G. 2, 01/104; R. 87/75. *Iron.*
M.P. 82/32, 107; J.E.C. M.R. No. 16, 12/27. *Antimony, Iron, Silver.*
Bungonia, 3 miles east, 13 miles south; M.P. 82/117; J.E.C. Rec. V, pt. 2, 1897; E.F.P. M.R. p. 233. *Cobalt, Manganese.*
E.F.P. M.R. p. 450; Rec. VI, pt. 4, 00/311. *Mineral Spring.*
E.F.P. M.R. p. 429. *Tripolite.*
T.W.E.D. 91/230. *Gems, Beryl.*
Bungonia Caves, parish of Inverary. Clarke's Southern Gold Fields, N.S.W., 1860, p. 18. W.A. 89/232; W.S.L. 89/251, 91/281; O.T. 97/203, 00/198; Caves Guide, 1906; M.R. No. 25, 19/9, 10; Jerrara Caves, parish of Marulan, 6 miles south-east of Marulan. W.S.L. 90/311; Jerrara Creek, parishes of Bungonia and Jerrara, 1½ miles west to 3 miles north-west of Bungonia. Parishes of Marulan and Inverary, 3 miles south-east to 5 miles north-east. Parish of Quialigo, 11 miles south-west Limestone and Windellama Creeks. Parishes of Yarralaw and Cullulla, 10 miles south-west and south-south-west of Bungonia. J.E.C. and L.J.J. M.R. No. 25, 19/129, 133, 144, 145. *Marble, Limestone.*

BUNGOWANNAH. [*See* Albury.]
BUNGWALL. [*See* Bullah Delah.]
BUNKERS' CREEK. [*See* White Cliffs.]
BUNKERS' HILL. [*See* Nuntherungie.]
BUNNABY CREEK. [*See* Taralga.]

Digitized by Google

BUNNAMAGOO. Near Rockley. *Gold, Copper.*

BUNYAN. [*See* Cooma.]

BURDETT. [*See* Canowindra.]

BURKE'S CREEK. [*See* Pulletop.]

BURLY JACKY. [*See* Woodstock.]

BURNEAL CREEK. [*See* Copeland.]

BURNT YARDS. [*See* Carcoar.]

BURRA CREEK. [*See* Captain's Flat, Queanbeyan and Tumbarumba.]

BURRA BURRA. [*See* Fifield.]

BURRA BURRA, NEW. [*See* Canbelego.]

BURRAGA. Thompson's Creek, south side, parishes of Jeremy and Thompson, county of Georgiana; Burraga to 5 miles west-south-west; parish of Isabella, 11 miles east of Burraga. J.E.C. M.R. No. 6, 08/117, &c.; J.E.C. 14/196; R. 78/61, 81/35, 39, 82/35, 38, 83/126, 88/58, 67, 96/49, 98/71, 00/54, 01/53, 82, 02/48, 03/47, 04/45, 85, 05/44, 06/46, 07/51, 08/46, 10/47, 12/48, 13/51, 14/53, 84, 15/49, 16/48, 17/41, 18/39, 79. *Copper,*

R. 85/52, 88/53, 91/73. *Silver.*

Isabella and Little Rivers, 1 to 8 miles east of Burraga. R. 95/17, 96/26, 97/29, 99/22, 02/15, 05/12, 06/16, 07/18, 08/16, 11/17, 14/18, 16/16. *Gold.*

BURRAGATE. [*See* Pambula.]

BURRAMAGOO. [*See* Rockley.]

BURRAGORANG. [*See* Coal Index and Yerranderie.] Parish of Nattai, county of Camden. J.E.C. Mem. G. 3, 03/232; M.R. No. 25, 19/204. *Limestone.*

BURRAN BURRAN CAVES. [*See* Wellington.]

BURRANDONG. [*See* Stuart Town.]

BURRANGONG. [*See* Young.]

BURRAWONG CREEK. [*See* Wellington.]

BURRIL RANGE. [*See* Wellington.]

BURRINJUCK. [*See* Goodradigbee River.] Murrumbidgee River, above weir. L.F.H. 08/169. *Silver, Gold.*

BURROWA. [*See* Binalong and Boorowa.]

BURSTED BOULDER. [*See* Fifield.]

BUSHY CREEK (and Hill). [*See* Cooma.]

BUTCHER'S CREEK. [*See* Mount Macdonald.]

BUTLER'S FALLS. [*See* Hillgrove.]

BUTTAI. [*See* Coal Index.]

BYADBO. Parish of Byadbo, county of Wellesley, 1½ mile north-west of Byadbo Station. *Silver.*

BYE ROCK. Parish of Howqua, county of Cowper, 12 miles east-north-east of Bye Rock. W.A. 87/102,; R. 05/14. *Gold.*

BYGOO. 14 to 20 miles north of Ardlethan. R. 17/47. *Tin.*

BYJERKERNO. [*See* Euriowie.]

BYNG. Mount Fraser, Carangara, Whitney Green at Byng. Parish of Byng, county of Bathurst, 12 miles east-south-east of Orange. C.S.W. 81/131; E.F.P. M.R. p. 152; J.E.C. M.R. No. 6, 08/126, &c.; R. 85/58, 86/15, 87/50, 52, 95/18, 97/30, 98/71, 01/54, 06/46, 07/52, 08/47, 16/48. *Gold, Copper, Silver.*

Digitized by Google

BYWONG. Sutton, Dairy, and Brook's Creeks, parish of Bywong, county of Murray, 9 miles north-west of Bungendore. M.P. 82/86; J.E.C. 95/132; M.R. No. 6, 99/66; Rec. VI, pt. 4, 00/199; R. 91/107, 95/24, 96/31, 03/27, 05/24, 07/17, 08/15, 09/14, 15, 14/16, 15/15, 16/14, 17/12, 18/11. *Gold, Copper, Silver.*

Dairy Creek and Gundaroo, north of Bywong, parishes of Talangandra and Purrorumba. J.B.J. 96/131; R. 95/24, 06/15, 08/15, 14/16 15/15, 16/14, 18/11. *Gold.*

M.P. 82/122. *Diamonds.*

CADIA. Cadiangullong Creek, parishes of Clarendon and Waldegrave, county of Bathurst, 12 miles south-south-west of Orange. C.S.W. 81/131 J.E.C. 99/171; M.R. No. 6, 08/127, 128, 132, 175; R. 90/63, 04/46, 05/44, 06/46, 07/52, 08/47, 09/47, 13/51, 88, 14/53, 86, 15/49, 86, 16/48, 83, 17/41.

Wallaby Rocks, between Cadia and Cadia Extended. J.E.C. M.R. No. 6, 08/175. *Copper.*

M.R. No. 25, 19/178. *Limestone.*

M.P. 82/108; J.B.J. 00/189, 04/70, 15/80; Mem. G. 2, 01/26, 157; E.F.P. M.R. p. 208; Iron Ore Deposits of N.S.W., 1910. A. 14/215; R. 18/48. *Iron.*

Four-mile Creek, &c. R. 00/15, 05/11, 08/16, 10/16. *Gold.*

CADIA CREEK. [*See* Orange.]

CALABASH CREEK. [*See* Colinton.]

CALAFAT. [*See* Adelong.]

CALARIE. [*See* Forbes.]

CALOOLA CREEK. [*See* Euriowie and Rockley.]

CALULA (Caleula Quarries). South of Kerr's or Larras Lake Creek, parish of Mulyan, county of Wellington, 15 miles north of Orange. R. 98/78, 01/62, 02/59, 14/67, 15/63, 16/63, 17/56, 18/63. *Limestone, Marble.*

Parish of Larras Lake.

R. 91/70, 92/49, 07/66; Assay 07/182, 16/220. *Iron oxide pigments.*

Assay 07/181. *Manganese.*

R. 18/39. *Copper.*

CAMBEWARRA. [*See* Coal Index.]

CAMELBACK MOUNTAIN. Grafton District. J.E.C. M.R. No. 6, 08/187. *Copper.*

CAMERON'S CREEK. [*See* Armidale.]

CAMPBELL'S CREEK. [*See* Windeyer.]

CAMPBELL RIVER. [*See* Oberon and Rockley.]

CAMP FIRE. [*See* Swamp Oak.]

CANBELEGO. At junction of Counties of Canbelego, Flinders, Mouramba and Robinson. Comprehensive report E.C.A. M.R. No. 18, 1913.

Mount Boppy, parish of Cohn, county of Robinson, parish of Florida, County of Canbelego. J.B.J. 05/69; Rec. VIII, pt. 2, 1906; E.C.A. 12/177; R. 00/34, 103, 01/32, 89, 02/16, 79, 03/13, 04/13, 89, 05/13, 06/11, 94, 07/13, 90, 08/11, 45, 95, 09/10, 10/11, 11/11, 51, 89, 12/11, 93, 13/11, 105, 14/11, 100, 15/11, 97 (17/10 comprehensive). Bores 14/79, 15/75, 16/11, 17/91, 18/10, 93. *Gold.*

18/94. *Manganese.*

Hermitage Plains. Burra Burra or Mount Boppy, parish of Geweroo, county of Flinders. *Copper.*

Digitized by Google

New Burra Burra, parish of Buppe, county of Mouramba, south and south-east of Mount Boppy Railway Station. J.E.C. M.R. No. 6, 08/196, &c.: R. 85/38, 86/105, 90/130, 91/149, 96/144, 97/93, 98/100, 99/98, 09/46, 107, 10/46, 96, 11/89, 14/100, 16/47, 17/91, 18/93. *Copper.*

Parish of Cohn, county of Robinson, west and north-west of Canbelego. J.E.C. M.R. No. 6, 08/194; R. 01/53, 07/51, 90, 09/108, 10/96, 11/51, 12/47, 13/51, 103, 14/52. *Copper.*

Parish of Tritton, county of Canbelego, 22 miles north-east of Canbelego. J.E.C. M.R. No. 6, 08/194. *Copper.*

Parishes of Howgill and Bulga, county of Flinders, 14 miles south-south-east of Canbelego. [*See* Restdown.] M.R. No. 25, 19/232. *Limestone.*

CANBERRA. Molonglo River, parishes of Narrabundah and Canberra, at Canberra, parish of Yarrolumla, 5 miles south-west of Canberra, county of Murray. M.R. No. 25, 19/284. *Limestone.*

CANDELO. Parish of Candelo, county of Auckland; 4 miles west of Candelo, 15 miles north-west of Pambula. Assay 12/195, 13/188. *Silver Barytes.*

CANGAI. Gap Creek, Yantalla or Stockyard Creek; Mitchell or Mann River, parish of Kaloe, county of Gresham; 21 miles south of Solferino. J.E.C. 07/169, M.R. No. 6, 08/180 186; R. 01/56, 04/47, 05/46, 06/48, 96 07/55, 92, 09/49, 10/49, 11/54, 12/51, 13/54, 14/55, 15/51, 16/20, 17/43. *Gold, Silver, Copper.*

Purgatory Creek; Parish of Braylesford, County of Gresham; 12 miles east of Cangai, 10 miles west of Copmanhurst. [*See* Copmanhurst.] J.E.C. M.R. No. 6, 08/162; M.R. No. 25, 19/251. *Copper, Limestone.*

Dandahra Creek; Parishes of Dandahra, Cooraldooral, Moogen and Coorandooral; County of Drake. J.E.C. M.R. No. 14, 11/293; R. 05/48, 11/58; Assay 06/181. *Tin.*

R. 15/58. *Antimony.*

Parishes of Cangai, Dandahra and Puhoi; County of Drake. R. 88/114, 00/32, 05/13. *Gold.*

R. 10/44, 11/49, 14/50. *Silver.*

Parish of Coorandooral, south-west of Cangai. R. 18/16. *Gold.*

CANOBLAS or Canobolas. Parish of Canobolas; County of Ashburnham; Parish of Towac; County of Bathurst; 9 to 12 miles south-west of Orange. J.E.C. M.R. No. 6, 18/133 *Copper.*

Bores 14/79, 15/76. *Silver.*

Soldier's Creek; south side of Canoblas; Parish of Clarendon; County of Bathurst. R. 81/36. *Gold.*

CANOWINDRA (Belmore). Belubula River; Parish of Canowindra; County of Bathurst, parish of Collett, county of Ashburnham. R. 75/78, 76/61, 80/112, 81/56, 82/52, 84/80, 88/80, 89/132, 92/19, 95/20, 97/27, 03/12, 04/12, 05/12, 06/16, 09/16, 10/17, 11/18, 12/16, 13/17, 14/18. *Gold.*

Jack's Creek. R. 02/15 *Gold.*

Digitized by Google

Burdett, parish of Toogong, county of Ashburnham, 11 miles north of Canowindra. *Gold.*

Barringun, parish of Barrajin, 6 miles north-east of Canowindra. M.M. 17/169; R. 18/64, 77. *Phosphates.*

J.E.C. 14/209; Between Canowindra and Gregra *Limestone.*

CAPERTEE. [*See* Coal Index.] Parish of Morundurey, county of Roxburgh; 5 miles east-north-east and 10 miles north-north-east of Capertee. J.E.C. Mem. G. 3, 03/131, G. 6, 08/249; R. 06/18, 16/18. *Gold.*

Parish of Bandamora. J.E.C. M.R. No. 6, 08/300. *Copper.*

Carlos Gap, parish of Airly. J.A.W. 97/183; J.B.J. Mem. G. 2, 01/106, 109, 116; E.F.P. M.R. p. 199. *Iron.*

Near Capertee, 22 miles north of Wallerawang. E.F.P. M.R. p. 306; E.C.A. M.R. No. 24, 16/73. *Molybdenite.*

Between Capertee and Wolgan River. Assay 06/80. *Manganese.*

Blue Rock, Parish of Goollooinboin, county of Cook, 8 miles east-south-east of Capertee; Cocko Creek, parish of Coco, county of Roxburgh, 6 miles east of Capertee. J.E.C. Mem. G. 3, 03/124, G. 6, 08/244; M.R. No. 25, 19/207. *Limestone.*

Excelsior, 1 mile south-west of Carlos Gap, and 2 miles east-north-east, parish of Airly, county of Roxburgh, 7½ miles north of Capertee. J.E.C. Mem. G. 6, 08/246, 253; R. 01/62, 04/52, 05/51, 07/61. [*See* Brogan's Creek.] M.R. No 25, 19/311. *Limestone.*

Green Hills, near Glen Alice. J.E.C. Mem. G. 6, 08/233.

Glen Alice, parish of Umbiella, county of Roxburgh, 16 miles north-east of Capertee. M.R. No. 25, 19/323. *Limestone.*

CAPTAIN'S FLAT. Molonglo River, Lake George Mines, parish of Ballallaba and Bullongong, county of Murray, 20 miles south-east of Queanbeyan. J.E.C. M.R. No. 6, 08/337, &c.; E.F.P. M.R. p. 174; R. 83/82, 85/77, 92/39, 93/40, 95/24, 56, 61, 99/64, 05/45, 11/53, 12/49, 13/52, 14/17, 15/15, 50, 16/15, 49, 17/42. *Copper, Gold, Silver.*

Norongo, Queanbeyan River, parish of Jinjera, county of Murray, 8 miles south of Captain's Flat. T.W.E.D. and J.C.H.M. Rec. 1, 89-90/26; J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 263. *Bismuth.*

Assays 06/179, 12/195, 16/219. *Cobalt Barytes.*

Parish of Ballallaba, 3 miles north of Captain's Flat; Queanbeyan River, parish of Jinjera, 9 miles south London Bridge, Limestone and Burra Creeks, parishes of Burra and Urialla, 12 miles west-north-west to west-south-west of Captain's Flat. M.R. No 25, 19/282, 290, 295, 296. *Limestone.*

CAPOOMPETA MOUNT. [*See* Bolivia.]

CAPPANANA CREEK. [*See* Bredbo.]

CARABOST. Parishes of Carabost and Bulalgee, county of Wynyard, 20 miles north-west of Tumbarumba. R. 87/83, 95/23. *Gold.*

CARAGABEL RIVER. Euroka, parish of Barbingal, county of Bland, midway between Wyalong and Grenfell. C.S.W. 78/150; R. 87/64. *Gold.*

CARANGARA. [*See* Byng.]

CARANGULA. [*See* Munga Creek.]

CARBINE PADDOCK. [*See* Forest Reefs.]

CARBOONA. [*See* Jingellic.]

Digitized by Google

CARCOAR. [*See* Lyndhurst.] Coombing Estate, Belubula River, parishes of Somers and Shaw, county of Bathurst. Parliamentary papers Gold Fields of N.S.W. 1873–4. C.S.W. 78/150; J.E.C. 99/178; Rec. VI, pt. 4, 00/242, 243. *Gold.*

Flyer's Creek, 3 miles from Carcoar. R. 76/58, 60, 77; Lumpy Swamp, R. 76/59, 77, 03/13. [*See* Orange.] *Gold.*

Brown's Creek, Church and School Estate, parish of Calvert, 8 miles from Carcoar. R. 76/37, 76, 77/59, 116, 82/36, 37, 83/47. *Gold.*

Burnt Yards, parish of Belubula, 8 miles west of Carcoar. R. 76/77, 77/116, 05/12, 15/17. *Gold.*

Wire Gully, Rodd's Creek, parish of Blake, 10 miles west of Carcoar. R. 09/16, 10/17. *Gold.*

Teesdale, Neville, parish of Neville, 8 miles south-east of Carcoar. M.P. 82/86; R. 92/18, 03/13, 04/12, 05/12, 06/17, 07/19, 08/16, 09/16, 10/17. *Gold.*

Coombing Estate, Belubula River. T.W.E.D. 88/175; E.F.P. M.R. p. 224–226; R. 88/61, 65, 02/57. *Cobalt.*

M.P. 82/152; E.F.P. M.R. p. 152; J.E.C. M.R. No. 6, 08/135, 137, 170; R. 12/48. *Copper.*

J.B.J. 00/186; Mem. G. 2, 01/21, 157; E.F.P. M.R. p. 205; Iron Ore Deposits of N.S.W., 1910; J.E.C. Mem. G. 6, 08/232; M.R. No. 6, 08/137; R 98/27, 99/22, 01/83, 05/54, 06/54, 07/60, 11/60, 12/56, 14/60, 15/55, 17/48, 18/48, 77; Assay 16/220. *Iron.*

E.C.A. M.R. No. 24, 16/73. *Molybdenite.*

3 miles east of Carcoar. Assay 16/220. *Phosphates.*

District. R. 18/62. *Barytes.*

CARGELLIGO. [*See* Cudgellico.] Parishes of Cargelligo, Narden, &c., county of Dowling, 17 miles east-south-east of Cargelligo. M.R. No. 25, 19/221. *Limestone.*

Parish of Bygalore, county of Gipps, between Ungarie and Cargelligo. *Travertine.*

CARGO. Cargo Gum Flat, Iron Clad Hill, &c., parish of Cargo, county of Ashburnham. Parliamentary papers, Gold Fields of N.S.W., 1873–4; Mines and Min. Stat. 75/41; C.S.W. 78/152; W.A. 90/267; E.C.A. and M.M. M.R. No. 19, 1915; R. 75/76, 77, 76/61, 77/162, 98/33, 99/27, 01/21, 83, 03/15, 04/15, 80, 05/18, 06/12, 07/13, 08/12, 11/11, 12/11, 13/12, 14/12. A. 06/175. *Gold.*

Boney's Rocks, 10 miles north-west of Cargo, near Toogong. R. 81/56, 86/63, 90/74. *Gold.*

Dalcoutt and Iron Clad Hills. W.A. 90/268; J.C.H.M.06/175; J.E.C. M.R. No. 6, 08/273; R. 79/100, 88/80. *Copper.*

Canomodine Creek, Limestone Valley, Grove Creek, Belubula River, parishes of Cargo, Barrajin, Collett and Canomodine, county of Ashburnham, parish of Chaucer, county of Bathurst; from Cargo to 7 miles south. *Limestone.*

Parish of Barrajin; R. 17/56. *Phosphates.*

Parish of Bowan, 5 miles north-east of Cargo. M.M. 17/167. *Tripolite.*

CARLISLE. Parish of Elsmore, county of Cunningham, 17 miles north-east of Condobolin. Australian Newspaper, May, 1896; E.F.P. 03/123; R 76/29, 96/68, 99/28, 10/12. *Gold.*

Digitized by Google

CARLISLE GULLY. [*See* Bendemere.]
CARLOS GAP. [*See* Coal Index and Capertee.]
CAROLINE. [*See* Tottenham.]
CARPATHIA. [*See* Ardlethan.]
CARTINA. [*See* Bobadah.]
CARRAI. Felton and Carrol's Creeks, Macleay River, Parish of Kunderang, county of Vernon, 35 miles west-north-west of Kempsey. C.S.W. 89/205; R. 99/72, 00/59, 03/140, 06/52, 07/58, 09/53 *Gold, Tin.*
J.E.C. M.R. No. 15, 12/78. *Sheelite.*
Parish of Warne, county of Dudley. E.C.A. M.R. No. 24, 16/74. *Molybdenite.*
CARRINGTON, MOUNT [*See* Drake and Nooroomna.]
CARROL CREEK, 6 miles south-east of Cudgegong. *Mercury.*
CARROLL'S CREEK. [*See* Carrai.]
M.P. 82/103, east of Gunnedah, Mooki River. *Tin.*
CARTWRIGHT'S CREEK. Parish of Para, county of Yancowinna, 9 miles north-north-west of Purnamoota, 28 miles north-north-west of Broken Hill. J B J. Mem G. 5, 94/45; M R No 25, 19/352. *Limestone.*
CARWARY. Shoalhaven District. M.P. 82/107. *Iron.*
CARWELL CREEK. South-west of Rylstone. [*See* Cudgegong.]
CASINO. Richmond River. County of Richmond. J.E.C. M.R. No. 6, 99/72; M.R. No. 15, 12/53; E.F.P., p. 298 (assays) *Copper, Zinc, Sheelite.*
CASTLE RAG CREEK. [*See* Deepwater.]
CATHCART. Parish of Cathcart, county of Wellesley. J.E.C. 04/140; M.R. No. 14, 11/281, 284, 286; R. 90/81, 82, 89/85, 91/91, 00/58. *Gold, Tin.*
Knox's Valley. Assay 13/188 *Barytes.*
Tantawangalo, parish of Bredbondoura, county of Auckland, east and north-east of Cathcart. J.E.C. 04/140; R. 89/85, 03/24, 04/24, 06/23. *Gold, Tin.*
Parishes of Bredbendoura and Yuglamah, county of Auckland.
Parish of Creewah, county of Wellesley. E.C.A. M.R. No. 24, 16/143; R. 14/84. *Molybdenite.*
Creewah, parishes of Creewah and Cathcart, 7 and 5 miles north-east of Cathcart. J.E.C. M.R. No. 15, 12/53; L.J.J. 17/171. *Wolfram.*
CATOMBAL RANGE. [*See* Wellington.]
CAVAN and CAVE FLAT CAVES. [*See* Goodradigbee River and Yass.]
CAWKER'S WELL. Parish of Willis, county of Young, 27 miles west-south-west of Wilcannia. R. 89/124, 90/126. *Gold.*
CEDAR LOG or Brush Creek. Parish of Mitchell, county of Clarke, east of Kookarabooka. *Gold.*
CELLS CREEK. Parish of Graeme, county of Macquarie, 34 miles north-west of Wingham. R. 95/26, 96/34, 97/43, 00/27. *Gold.*
J.E.C. M.R. No. 6, 99/72. *Copper.*
Tobins, 5 miles from, E.F.P. M.R., p. 372. *Graphite.*
CEMETERY CREEK. [*See* Wilson's Downfall.]
CESSNOCK. [*See* Coal Index.]
CHAMBERS CREEK. [*See* Hill End.]
CHAMBIGNE. O.B.X. C.R., parish of Ermington, county of Fitzroy. R. 83/110. *Gold.*

Digitized by Google

CHAMPION CREEK. [*See* Woogoolga.]

CHANCE CREEK. Rocky River, parish of Maclean, county of Clive. R. 04/21, 05/16. *Gold.*

CHANDLER RIVER.

Long Point, Warm Corner, Hall's Peak, &c., parishes of Clarke and Tiara, county of Clarke, parishes of Ferryman and Shasta, county of Sandon, 28 miles south-south-east of Armidale. J.B.J. 96/141, 13/81; J.E.C. 98/158; M.R. No. 6, 08/330.

R. 97/63, 10/49, 11/55, 13/54, 14/55, 88, 15/51, 16/44, 17/39, 18/36. *Gold, Silver, Copper.*

CHATHAM. [*See* Taree.]

CHATSBURY. Parishes of Turallo and Tarlo, county of Argyle, 17 miles north of Goulburn. J.F.C. and E.C.A. 13/181, 16/199; R. 13/67, 14/68, 15/64, 16/64, 18/65; A. 17/178. *Slate.*

CHATSWORTH. [*See* Coal Index.]

CHEITMORE. [*See* Wyanbene.]

CHERRY HILL. [*See* Tumbarumba.]

CHERRY TREE. [*See* Dungog.]

CHESHIRE CREEK. [*See* Limekilns.] North of Bathurst, county of Roxburgh. R. 04/11. *Gold.*

CHEVIOT STATION. North-east of Drake. E.C.A. M.R. No. 24, 16/84. *Molybdenite* (traces.)

CLANDULLA. Parishes of Mead and Warrangunia, county of Roxburgh. M.R. No. 25, 19/322, 323. *Limestone.*

CLARENCE MOUNT. [*See* Coal Index.]

Parish of Lett, county of Cook. M.P. 82/28; R. 83/34. *Iron.*

CLARENCE COAL BASIN. [*See* Coal Index.]

CLARENCE RIVER. [*See* Gordon Brook and Lionsville.] Rec. VI, pt. 4, 00/201.

CLARENCE SIDING. J.E.C. Mem. G. 6, 08/238. *Pottery Clay.*

CLARENCE TOWN. Williams River, parishes of Wallarobba and Uffington, county of Durham, parish of Wilmot, county of Gloucester. J.B.J. 98/167; Mem. G. 2, 01/73, &c.; E.F.P., Iron ore deposits of N.S.W., 1910. *Iron.*

Joe's Yards, Limeburner's Creek, parish of Horton, county of Gloucester, 5 miles north-north-east of Clarence Town, near Williams River, 7 miles north: Parish of Wallarobba, county of Durham, 4 miles north of Clarence Town. J.B.J. Mem. G. 2, 1901; J.E.C. and L.J.J. M.R. No. 25, 19/229, 249. *Limestone.*

CLAREVAULX. East of Wellingrove. *Silver.*

CLARKE'S CREEK. [*See* Bega and Windeyer.]

CLEAR CREEK. [*See* Bathurst and Limekilns.]

Peel River. Assay, 78/11. *Iron with Gold and Silver.*

CLIEFDEN STATION. [*See* Manduramah.] Caves. [*See* Belubula.]

CLIFTON, MOUNT. [*See* Pulletop.]

CLOUGH'S GULLY. [*See* Gulgong.]

CLYDE MALLOW. [*See* Bateman's Bay.]

CLYDE RIVER. COAL CLIFF. COAL CREEK. COAL GULLY. COALDALE. [*See* Coal Index.]

Digitized by Google

COAN DOWNS AND PEAK. [*See* Mount Hope.]

COBALT. [*See* Deepwater.]

COBAR. Parish of Cobar, &c., county of Robinson.

Comprehensive Reports. J.E.C. M.R. No. 6, 08/17, 25, 198, &c. E.F.P. M.R. p. 51, &c.; E.C.A. 10/178, 14/196; M.R. No. 17, 1911.

Additional Reports. M.P. 82/26.

Rec. Vol. 1, 89/47; J.E.C. 05/139, 06/166; R. 78/24, 79/171, 80/43, 216, 82/101, 83/117, 128, 86/105, 88/124, 89/126, 90/130, 91/140, 92/21, 93/65, 94/53, 95/29, 61, 96/36, 48, 97/50, 64, 98/99, 99/46, 69, 00/33, 57, 85, 101, 01/32, 53, 89, 02/16, 48, 77, 03/14, 46, 04/13, 45, 89, 05/13, 42, 45, 81, 06/11, 36, 45, 94, 07/13, 50, 90, 08/11, 45, 95, 09/10, 10/10, 11/10, 51, 88, 12/10, 47, 92, 94, 13/11, 50, 101, 103, 105, 14/11, 51, 99, 100, 15/11, 47, 96, 16/11, 46, 95, 17/40, 90, 18/10, 38, 92, 94. *Gold, Copper.*

The Peak. 5 miles south of Cobar.

E.F.P. M.R. p. 51; R. 95/29, 86, 98/69, 01/32, 05/13, 06/11. *Gold.*

R. 91/141, 06/42, 95, 07/47, 91, 11/48, 12/44, 13/47, 14/48, 15/45. *Silver, Lead.*

Amphitheatre. Parish of Toy, 9 miles west of Cobar. J.B.J. 95/175. *Gold.*

C.S.A. Mines. 7 miles north-north-west of Cobar. J. R. Godfrey, 16/99. *Copper, with Zinc, Lead, Gold, Silver.*

J.A.W. M.R. No. 4, 1898; J.E.C. M.R. No. 6, 99/24; E.F.P. M.R. p. 155, 264. *Bismuth.*

Cobar District. J.E.C. 97/169; E.F.P. M.R. 298. *Wolfram.*

Bee Mountain, Queen Bee, Mount Illewong, parish of Narri, 13 miles south-east of Cobar. J.B.J. 95/175; J.E.C. M.R. No. 6, 08/259; E.C.A. M.R. No. 17, 11/26, &c.; R. 04/89, 05/74, 06/45, 08/45, 13/102, 14/99, 101, 15/48, 96, 16/96.

R. 17/90. *Copper.*

R. 16/43. *Silver.*

Rookery. Parish of Bee, county of Robinson, and parish of Fisher, county of Mouramba, 20 miles south-east of Cobar.

J.B.J. M.R. No. 6, 08/260; E.C.A. M.R. No. 17, 11/37.

R. 87/166, 07/181; M.R. No. 25, 19/311. *Limestone.*

Mallee Tank and Conqueror Mines, parish of Weltie, county of Robinson, 10 miles south-south-east of Cobar.

E.C.A. M.R. No. 17, 11/37. *Limestone.*

COBARGO. [*See* Bermaguee.]

COBAR RIVER. West of Copeland. *Gold.*

COBBADAH. [*See* Gulf Creek.]

Bell's Mount, parish of Cobbadah, county of Murchison, 4 miles south-east of Cobbadah. R. 15/62. *Tripolite.*

Oaky Creek, parish of Anderson, 4 miles north of Cobbadah. J.E.C. M.R. No. 16, 12/26, 30; Rec. VI, pt. 4, 00/190; R. 07/62. *Antimony.*

Oaky Creek. 3 miles north-west and 6 miles north-east of Cobbadah. *Gold.*

Oaky Creek, parish of Capel. 6 miles north-east of Cobbadah, 2 miles north-west of Gulf Creek Copper Mine. M.R. No. 25, 19/279. *Limestone.*

Digitized by Google

COBBORAH. Stringy Bark Fords and Tucklan Creeks, parishes of Yarrow and Tuckland, county of Lincoln, south-east of Cobborah.
J.B.J. 94/143; Rec. VI, pt. 4, 00/200; R. 94/22, 95/18, 96/27, 66, 97/30, 00/16, 09/17.
Tuttlan Scrubs, 80/96. *Gold.*

COBRA. [*See* Pambula.]

COCKROBY CREEK. [*See* Moruya.]

COCKWHY CREEK. [*See* Bateman's Bay.]

COCO CREEK. [*See* Capertee.]
Parish of Goollooinboin, county of Cook, 8 miles east-south-east of Capertee. J.E.C. Mem. G. 3, 03/131. *Gold.*

COCO RANGE. Western boundary, county of Mootwingee. C.S.W. 87/138. *Gold* (doubtful).

COFF'S HARBOUR. 5 to 7 miles south of Harbour. Assay, 07/182. *Mercury.*
Parish of Coff, county of Fitzroy. R. 11/55. *Copper.*

COLINTON. County of Beresford.
R. 90/81, 95/23, 97/38, 14/84. *Gold.*
Calabash Creek, parish of Onslow.
M.P. 82/121; D. C. McLachlan, Diamonds in N.S.W., 99/5. *Diamonds.*
Parish of Gungoandra, south and 5 miles east of Colinton;
R. 08/42, 09/43, 10/43, 14/84. *Silver, Lead.*
Assay, 03/141. *Hematite.*
Limekiln Gully, Queanbeyan River, parishes of Holland and Milford, county of Beresford, 26 miles east of Colinton. M.R. No. 25, 19/190. *Limestone.*

COLLAS HILL. [*See* Cope's Creek.]

COLLECTOR. Parish of Currowang, county of Argyle, 4 miles north-north-east of Lake George, 6 miles south-east of Collector. C.S.W. 84/146; J.E.C. M.R. No. 6, 08/341; R. 75/90, 08/21, 11/53. *Copper, Gold.*
Parish of Milbang, north-west of Collector. R. 18/39. *Copper.*
Parish of Tarago, county of Argyle, 6 miles east of Collector. *Limestone.*

COLLUM COLLUM CREEK. [*See* Lionsville.]

COLO CREEK. [*See* Trunkey.]

COLO RIVER. County of Cook, 22 miles south-east of Capertee. *Gold.*

COLO VALE. North of Mittagong.

COLONG. Colong Caves, Lanigan's Creek, Tuglow River, parishes of Colong and Tartarus, county of Westmoreland, 6 miles south-west of Yerranderie. O.T. 99/211. M.R. No. 25, 19/345. *Limestone.*
The Big Rock, Myangle Hill. A. 06/180. *Iron, Gold, Silver.*

COMAN MOUNT. [*See* Noorooma.]

COMBANING. County of Bland. R. 13/14, 14/14. *Gold.*

COMBANDRY. [*See* Gulgong.]

COMBOYNE. Parish of Innis, county of Macquarie, 22 miles south-west of Wauchope. L.J.J. 18/163; M.R. No. 25, 19/271. *Limestone.*

COMMISSIONERS' CREEK. Parish of Toolond, county of Rous. J.E.C. M.R. No. 14, 11/293. *Tin.*

CONAPAIRA. [*See* Rankin's Springs.]

Digitized by Google

CONDOBOLIN (Condoublin.) [*See* Cugong.] Parish of Condobolin, county of Cunningham. E.F.P. 03/123; J.B.C. M.R. No. 6, 08/273, 282, 283.

R. 88/79, 92/168, 93/21, 97/12, 64, 00/55, 03/16, 05/42, 45, 06/43, 47, 07/47, 08/42, 48, 09/43, 10/44, 11/12, 48, 12/44, 13/47, 14/87, 15/12, 45, 87, 16/12, 17/38, 18/36, 77.
Gold, Silver, Lead, Copper, Zinc.

Carlisle, parish of Elamore, county of Cunningham, 17 to 19 miles north-east of Condobolin. E.F.P. 03/23; R. 76/29, 96/68, 99/28. *Gold.*

Melrose, parishes of Melrose and Mount Nobby, county of Cunningham, south of Melrose, parish of Wilmatha, county of Kennedy, 34 miles north-west of Condobolin.

P. T. Hammond, 92/169; J.B.J. 95/176; J.E.C. M.R. No. 6, 08/269, &c.; R. 84/117, 122, 88/77, 97/33, 06/47, 08/48, 09/47, 10/47, 11/52, 102. [*See* Melrose.] *Gold, Silver, Copper.*

Near Melrose Homestead. J.B.J. Rec. V, pt. 1, 1895.
Platinum with Gold.

Three Peak Range. R. 88/76, 09/47. *Silver, Copper.*

Melrose Plains, parishes of Burra and Tout, county of Kennedy, north of Melrose. [*See* Fifield.]

P. T. Hammond, 92/170; J.E.C. M.R. No. 6, 05/405.
Gold, Iron, Limestone.

Parish of Boona West, county of Cunningham, near Melrose. R. 76/47.
Copper, Iron.

Jumble Plains. M.P. 82/103; R. 76/47. *Gold, Tin.*

A. 07/178. *Cobalt.*

Mount Susannah, parishes of Melrose and Gindoono, county of Cunningham. J.E.C. M.R. No. 6, 08/279. *Copper.*

Mount Tinda, parish of Tollingo, county of Cunningham, 36 miles north-west of Condobolin. J.B.J. 95/176; P. T. Hammond, 92/169; R. 88/76. *Silver.*

Yellow Mountain, parish of Tinda, county of Cunningham, parish of The Bluff, county of Flinders, north of Mount Tinda, 15 miles south-east of Bobadah. J.E.C. M.R. No. 6, 08/248, 262; R. 97/33, 03/16.
Copper, Silver, Lead, Gold.

Mowabla, parishes of Baratta and Mowabla, county of Cunningham, 14 miles north-west of Condobolin. J.A.W. 97/184; E.F.P. 03/123; R. 97/33, 83, 84; 99/28, 02/16, 07/14, 08/12, 09/12, 10/12, 14/13, 15/12. *Gold.*

Derriwong, parish of Derriwong, county of Cunningham, 9 miles east of Condobolin. Assay 06/180. *Manganese.*

Iodide (Mineral Hill), parish of Taliagabeelba, county of Kennedy, 36 miles north-north-west of Condobolin. E.F.P. 12/170; R. 12/44, 13/13, 47, 88, 14/13, 48, 87, 15/45, 86, 16/12, 44, 17/76, 18/36, 77.
Silver, Lead, Gold.

Assay, 12/196, 197. *Magnesite.*

R. 11/52, 13/12, 16/49. *Copper.*

CONDON CREEK. [*See* Monaya.]

Blind Calf, 4 miles south-west from Mineral Hill. R. 17/76. *Copper.*

Digitized by Google

CONGWARRA. Paddy's River and Junction of Cotter and Murrumbidgee Rivers, parish of Congwarra, county of Cowley. J.E.C. 98/160; M.R. No. 6, 08/379, 389; M.R. No. 25, 19/211. *Copper, Limestone.*

J.B.J. Mem. G. 2, 01/60, 158; E.F.P. M.R., p. 212, Iron ore deposits of N.S.W., 1910; R. 95/61, 07/53, 08/48; Assay 02/131, 07/180, 13/189. *Iron, Magnesite, Silver.*

CONJOLA. Parish of Little Forest, county of St. Vincent, 15 miles north-west of Milton. J.E.C. M.R. No. 6, 08/338; L.F.H. Mem. G. 7, 15/274; R. 07/54, 81, 08/49, 09/48. *Copper.*

C.S.W. 90/202; R. 96/32. *Gold.*

CONNINGDALE. [*See* Hillgrove.]

CONQUEROR MOUNT. [*See* Bathurst.]

COOKAMIDGERA. County of Ashburnham. Assay 03/141, 04/152, 06/180. R. 18/77. *Manganese.*

COOKBUNDOON RANGE. [*See* Towrang.]

COOK'S VALE CREEK. [*See* Tuena.]

COOLABAH. Wilga Dam. R. 95/85. *Gold.*

COOLAC. Mooney Mooney Range, parishes of Gobarralong, county of Harden, and Darbalara, county of Buccleuch. J.E.C. 92/153, 97/149. *Chromite.*

R. 18/11. *Gold.*

Parish of Mooney Mooney, county of Harden, east of Muttama Creek, between Coolac and Muttama. *Limestone.*

COOLAH PINE RIDGE. [*See* Dunedoo.]

COOLAGALITE CREEK. [*See* Bermaguee.]

COOLANGUBRA. [*See* Bombala.]

COOLEMAN. Cooleman Caves, Cooleman Creek, Goodradigbee River, parishes of Cooleman and Murray, county of Cowley, 13 miles east-north-east of Yarrangobilly. R.E. and W.S.L. 93/134; J.E.C. and L.J.J. M.R. No. 25, 19/212. *Limestone.*

R. 18/39. *Gold.*

J.E.C. 00/184. *Silver* (trace).

Goodradigbee River, parish of Bimberi, north-east of Cooleman. R. 82/74, 13/16, 14/16. *Gold.*

COOLONGOLOOK (Gooloongolok) and Telararee, parishes of Curreeki and Gooloongolok, county of Gloucester. J.E.C. Rec. V, pt. 2, 97/58, R. 79/187, 07/23, 10/21, 11/24, 14/24. *Gold.*

Maclean or Wang Wauk Creek. J.E.C. M.R. No. 16, 12/47; R. 90/113, 06/178. *Antimony.*

Mount Boolbie, 7 to 10 miles west of Coolongolook. R. 79/188. *Gold.*

COOLUMBARRA. [*See* Narriga.]

COOMA. Bushy Hill, Dartmoor, Nitholm, &c., parishes of Bunyan, Cooma, and Montagu, county of Beresford. E.F.P. 98/161; M.P. p. 63; J.E.C. 98/157, 162; M.R. No. 6, 08/377, 380, 390; W. R. Browne, Roy. Soc. N.S.W., XLVIII, p. 208; R. 95/23, 97/38, 64, 86, 98/39, 68, 95, 99/33, 39, 68, 01/26, 07/17, 13/15, 52. *Gold, Silver, Copper.*

Parish of Cooma, Roy. Soc. N.S.W., XLVIII, p. 209. R. 12/195, 13/66. 14/67, 214. *Barytes.*

Parish of Bunyan. E.F.P. M.R. p. 429; W. R. Browne, Roy. Soc, N.S.W., XLVIII, p. 205, 209; G.W.C. and W.S.D., Rec. V, pt. 3, 97/142; R. 95/69, 96/51, 146, 07/66, 09/60, 10/59, 11/66, 12/61, 13/66, 14/67, 15/62, 16/67, 17/55. *Tripolite.*

Digitized by Google

Maffra. Assay 06/179, 14/214. *Hematite, Pottery Clay.*
Assay 06/180. *Nickel.*
Three and 16 miles from Cooma. E.F.P. M.R. p. 298; J.E.C. M.R. No. 15, 12/83. *Sheelite, Tungsten.*
Jeff's Creek, parishes of Gygederick and Cootralantra, county of Wallace, 12 to 15 miles south-west of Cooma. J.E.C. M.R. No. 6, 08/378, 381; R. 06/48, 08/48. [*See* Berridale.] *Copper, Gold, Silver.*
Rock Lodge, 20 miles from Cooma. *Gold, Silver.*
Rock Flat Creek, county of Beresford, 10 miles south-east of Cooma. Dixon 79/48; W.A. Rec. No. 1, 1899–90; E.F.P. M.R. p. 449; W. R. Browne, Roy. Soc. N.S.W., XLVIII, p. 205; Rec. VI, pt. 4, 00/205. A. 79/48. *Mineral Spring, Travertine.*
Parish of Jillimatong, south-west of Cooma, Rec. VI, pt. 4, 00/196, 197. *Gold.*
Toll Bar Bridge, Rock Flat Creek, and Rosebrook Caves, Bunyan, parishes of Bunyan and Wolumla, county of Beresford. 4 to 7 miles north-east of Cooma. W.A. 89/232, W.S.L. 92/176, 93/77, 94/157; Papers M. 96/19,597. W. R. Browne, Roy. Soc. N.S.W., Vol. XLVIII, p. 194–209; M.R. No. 25, 19/187. *Limestone.*
Junction of Jack's, White, Flat Creek and Dangelong Creek, Umaralla River, parishes of Dangelong, Montagu, Palmerston, and Rivers; Tom Grogan's Creek, parish of Bulgandramine, county of Beresford. [*See* Kybean.] 9 miles east to 16 miles south-east of Cooma. M.R. No. 25, 19/189, 192. *Limestone.*

Coombing Park. [*See* Carcoar.]

Coonabarabran. [*See* Coal Index, and Warrumbungles, Scabby Rock, or Mooren, county of Gowen, 10 miles north of Coonabarabran. R. 98/50. *Gold.*
Parish of Tooraweenah, county of Gowen, 24 miles south-west of Coonabarabran. *Opal.*

Coonamble. [*See* Coal Index.]

Cooplacurripa Creek. [*See* Nowendoc.]

Coorabin. [*See* Coal Index.]

Cooraldooral Creek. Parish of Cooraldooral, county of Drake, west of Cangi, 10 miles north of Newton Boyd. R. 17/17. *Gold.*

Cootamundra. Bauloora and Kootra Mines, Mount Felstead, parishes of Dudauman and Yeo Yeo, county of Bland, 5 to 8 miles north-west of Cootamundra. J.E.C. 03/125; M.R. No. 6, 08/273, 274, 278; R. 03/48, 74, 139, 140, 04/151, 05/45, 06/181, 07/53, 08/48, 09/43, 47, 10/43, 11/48, 12/44, 49, 13/47, 52, 14/49, 15/45; Assay 06/181. *Copper, Silver, Zinc.*
M.P. 82/118; Assays 03/141, 06/178, 07/180. *Chromite, Manganese.*
Cullinga, parish of Cullinga, county of Harden, 9 miles east of Cootamundra. L.F.H. 14/200; R. 92/19, 94/25, 99/29, 00/23, 01/23, 03/17, 05/19, 06/13, 08/12, 09/12, 10/13, 11/12, 12/12, 13/13, 14/13, 15/12, 16/12, 17/11, 18/10; Bores 15/76, Christmas Gift, Democrat, Cullenga, &c., Mines. *Silver, Gold.*
M.R. No. 25, 19/252. *Limestone.*

Cootawundy Range (Cotaurandee). [*See* Nuntherungie.]

Cootralantra. [*See* Cooma.]

Cooyal. [*See* Gulgong.]

Digitized by Google

COPELAND. Berrico Creek, parish of Berrico, county of Gloucester, 8 and 14 miles south of Copeland. R. 14/24, 01/86, 17/18, 18/16. *Gold.*

Boranel Creek, parish of Boranel, 11 miles west of Copeland. R. 14/24, 15/22, 17/18, 18/16. *Gold.*

Back Creek. Parish of Bindera. E.F.P. 77/10. *Gold.*

Bowman and River, parishes of Bowman and Craven, north-west of Copeland. E.F.P. 77/10; R. 81/87, 90/112, 91/129, 95/26, 01/26, 03/14, 04/14, 80, 05/14, 76, 06/21, 88, 07/23, 08/20, 87, 09/21, 92, 10/22, 11/24, 12/21, 13/23, 14/24, 15/22, 17/17, 18/16, 80. *Gold.*

Craven Creek, Little Manning River, parish of Craven. R. 06/21, 83, 07/23, 08/20, 09/21, 10/22, 11/24, 12/21, 15/22, 16/21. *Gold.*

Mountain Maid Creek, close to Copeland. R. 05/76, 06/83, 13/23, 16/21, 17/17, 18/16. *Gold.*

Kerriput, or Rawdon Vale, parish of Knowla, 10 to 15 miles west-south-west of Copeland. R. 82/107, 98/45, 99/38; 05/76, 09/21, 15/22, 16/21, 17/17, 18/16. *Gold.*

South of Barrington River, north of Dilgry River, parishes of Bindera, Boranel, and Knowla, county of Gloucester, 8 miles west to 11 miles west-north-west of Copeland. M.R. No. 25, 19/239, 241. *Limestone.*

North of Manning River, parish of Dowitt, county of Hawes, 25 miles north of Copeland, 29 miles south of Nowendoc. J.E.C. M.R. No. 6, 08/319. *Copper.*

COPE'S CREEK. [*See* Inverell, Tingha, and Copeton.]

COPETON (late Boggy Camp.) [*See* Tingha.]

Cope's Creek and Gwydir River junction, parish of Mayo, county of Hardinge, and 3 miles south in parish of Aston, 12 to 15 miles south of Inverell. E.F.P. 96/98; M.R., p. 388-391.

R. 95/68, 99/78, 00/61, 01/59, 02/53, 03/52, 04/50, 06/50, 52, 07/58, 08/53, 09/53, 10/52, 11/59, 12/55, 13/59, 14/59, 15/54, 17/48, 18/46, 84. *Diamonds, Tin.*

Oaky Creek. E.F.P. 04/137; R. 04/87. *Diamonds.*

Pepps Flat. J.E.C. M.R. No. 15, 12/85. *Tin, Diamonds, Sheelite.*

Parish of Clare, north of Copeton. J.E.C. M.R. No. 6, 08/327; R. 14/59. *Copper stains.*

COPMANHURST. [*See* Cangai.] Purgatory Creek, parish of Braylesford, county of Gresham, 8 miles west of Copmanhurst, 12 miles from Cangai. J.E.C. M.R. No. 6, 08/182; M.R. No. 25, 19/251; R. 14/55, 15/51, 16/50. *Limestone, Copper.*

COPPABELLA. Parishes of Coppabella and Yarara, county of Goulburn, 18 miles south-west of Tumbarumba. J.E.C. M.R. No. 6, 99/164. *Copper* (poor.)

R. 76/66, 02/28, 05/23, 06/15, 07/17. *Gold.*

Lankey's Creek, parishes of Coppabella, Currajong, and Yarara, Four Mile Creek Gold Field. J.E.C. 08/166; M.R. No. 14, 11/262, 268; R. 04/26, 00/25, 01/58, 04/50. *Tin and Gold.*

Parishes of Coppabella, Currajong, and Yarara, county of Goulburn, parishes of Jingellec east and Glenken, county of Selwyn. J.E.C. 05/146; R. 88/91, 05/42, 06/42, 13/47, 14/48, 18/37. *Silver.*

Mount Gifford, parish of Currajong. J.E.C. M.R. No. 15, 12/62, 83. *Wolfram, Sheelite.*

Parish of Coppabella, 3 miles east of Lankey Creek. Assay 16/220. R. 18/37. *Fluor Spar.*

Digitized by Google

COPPERHANNIA. [*See* Trunkey.]

COPPER HILL. [*See* Girilambone and Molong.]

COPPER MINE CREEK. [*See* Bélubula River and Yarrangobilly.]

CORADGERY. [*See* Alecktown.]

CORAMBA. 12 miles south-west of Woogoolga. Bucka Bucka Creek, east and north-east of Coramba. Kangari, 1½ miles south of Coramba, parish of Moonee. Tallawidjah Creek, parish of Bagawa, county of Fitzroy. J.E.C. 95/144; R. 95/29, 97/49, 00/32, 01/31, 02/16, 05/13, 06/20, 07/23, 08/20, 09/20, 10/21, 11/23, 12/20, 13/22, 14/24, 15/21, 16/20, 17/17, 18/16, 80. *Gold.*

Nana Nana Creek, Orara River, parish of Bagawa, &c. J.E.C. 95/144; R. 81/9, 82/108, 84/105, 85/98, 86/97, 87/102, 88/117, 89/119, 90/123, 91/133, 95/29, 98/52, 00/32, 01/32, 07/23, 55, 09/30, 10/21, 11/23, 13/22. *Gold.*

Tallawidjah Creek. Assay, 16/220. *Manganese.*

Bushmans' Range, Molo Creek, parish of Wilawan, 7 miles west of Nana. R. 98/53, 11/23, 16/20. *Gold.*

Kangari (Karangi). Between Coff's Harbour and Coramba. J.E.C. M.R. No. 6, 08/191; R. 07/23, 09/20, 10/21, 11/23, 55, 13/22, 14/24, 15/21, 16/50, 17/43; R. 17/78, 18/40. *Copper, with Gold and Silver.*

Parish of Moonee, south of Coramba. J.E.C. M.R. No. 6, 08/191.

Dairyville, Mounts Brown and Bischoff. R. 18/40. *Copper.*

Mole and Bobo Creeks, Little and Upper Nymboida Rivers, parishes of Gundar and Ucombe. R. 06/21, 07/23, 08/20, 09/20, 13/22, 14/24, 15/21. *Gold.*

Upper Orara River. Assay, 07/182. *Manganese.*

CORANG RIVER. Shoalhaven River, parish of Jerricknorra, county of St. Vincent, 20 miles north-north-east of Braidwood. J.B.J. 98/171; R. 86/73. *Gold.*

Parishes of Wog Wog and Corang. L.F.H. 04/146. *Kerosene Shale* (doubtful.)

Jerricknorra. J.B.J. M.R. No. 6, 99/122; R. 09/48. *Copper* (doubtful.)

Yellow Springs, near Corang. R. 77/127. *Gold.*

CORANGULA (Carangula). [*See* Munga Creek.]

CORDEAUX RIVER. Near Mount Keira. M.P. 82/122. *Plumbago.*

CORDILLERA. [*See* Tuena.]

COREE, MOUNT. Mount Blundell, parishes of Urayarra and Coree, county of Cowley, 24 miles west of Queanbeyan. J.B.J. 96/139; J.E.C. M.R. No. 6, 08/391. *Copper, Gold, Silver.*

CORINDA CREEK. [*See* Woogoolga.]

CORONA. Morphett's Creek, parishes of Badjerrigarn and Corona, county of Farnell, 14 miles north of Torrowangee. C.S.W. 87/138; J.B.J. Mem. G. 5, 94/132. *Iron, Manganese, Silver.*

Assay, 07/188. *Tin.*

Corona Station and North, parishes of Cook and Badjerrigarn, 48 miles north of Broken Hill. [*See* Torrowangee.] C.S.W. 84/147; Rec. Vol. 1, 89/2; J.E.C. and L.J.J. M.R. No. 25, 19/229. *Limestone.*

CORONGA PEAK. County of Cowper, 20 miles south of Byrock. R. 02/17. *Gold.*

Digitized by Google

COROWA. Rutherglen Deep Lead, Murray River, county of Hume; 8 to 12 miles north-east of Corowa. E.F.P. M.R. p. 13; R. 94/6, 95/85, 00/25, 02/27, 04/26, 07/179, 18/11; Papers Prospecting Board, 98/4,362, 04/3,268. *Gold.*

Cropper's Lagoon, Dredge 11/29. *Gold.*

Nulla Nulla or Redland, north and north-east of Corowa. R. 82/74, 95/85, 15/14, 16/13, 17/12. *Gold.*

CORROWIDGIN. Late Currowang. [*See* Delegate.]

CORUNNA. [*See* Noorooma.]

COSTIGAN MOUNT. [*See* Tuena.]

COTTER RIVER. [*See* Congwarra.]

COWABBIE. Parish of Brangalgan, Yarranderry and Cowabbie, county of Bourke, 25 miles east-north-east of Narrandera, 15 to 20 miles north-east of Grong Grong. M.P. 82/24, 66; R. 88/93, 91/105, 98/38, 99/31, 07/16, 08/14, 09/14. *Gold.*

COWAL, LAKE. [*See* Billy's Look Out and Wamboyne.]

COWARRAL. Hastings River, parish of Jasper, county of Macquarie, 40 miles west of Port Macquarie. R. 80/154 *Gold.*

COW FLAT. [*See* Pyramul, Rockley and Rockvale.

COWL CREEK. [*See* Gilgunnia.]

COWRA. Binni Creek, parish of Cowra, county of Bathurst, 3 miles north and north-east of Cowra. J.B.J. 95/174; R. 94/20, 95/16, 99/21, 00/13, 05/12. *Gold.*

South Clunes, Binni Creek. R. 16/48. *Copper.*

Parish of Coota; 4 miles east-north-east of Cowra. J.E.C. M.R. No. 6, 08/141, 147. *Copper.*

Wallaroo Range, 7 miles north of Cowra. C.S.W. 78/150. *Gold.*

Tenandra, Sam's Reef, parish of Tenandra; 9 miles north of Cowra, 7 miles north-west of Woodstock. R. 90/85, 93/20, 16/16. *Gold.*

Broula Range, parish of Broula, county of Forbes; 11 miles south-west of Cowra. J.E.C. M.R. No. 6, 08/271; R. 98/26, 99/66, 04/46, 11/12. *Copper.*

Foot of Broula Range. J.B.J. Mem. G. 2, 01/56, 158; E.F.P. Iron Ore deposits of N.S.W., 1910. *Iron.*

Neila Creek, parish of Neila, 12 miles south-east of Forbes. R. 05/12; parish of Morongla, R. 17/14. *Gold.*

Morongla Creek, parish of Morongla, 6 to 10 miles south of Cowra. J.E.C. M.R. No. 6, 08/280; R. 02/49, 06/47, 09/47. *Copper.*

Holmwood, Illunie Range, parish of Bang Bang, 18 miles south of Cowra; Illunie, near Koorowatha. J.B.J. 01/166; J.E.C. M.R. No. 6, 08/148, 276; R. 01/82, 02/49, 05/12, 44; R. 16/48; Assay 02/131 *Gold, Iron, Copper.*

Cowra District. J.E.C. M.R. No. 2, 1898; E.F.P. M.R. p. 298. *Wolfram.*

Neila Creek, parish of Morongla, county of Forbes, 3 miles south-east of Cowra.

Grenfell Road, parish of Broula, 12 miles west of Cowra. M.R. No. 25 19/232. *Limestone.*

COWRA CREEK. [*See* Bredbo.]

COX'S RIVER. [*See* Hartley.] J.E.C. Mem. G 6, 08/249. *Gold.*

COX'S CREEK. [*See* Warialda.]

CRABOON. [*See* Dunedoo.]

Digitized by Google

CRACKENBACK RANGE. [*See* Jindabyne.]
CRAIGIE. [*See* Delegate.]
CRAIG LEA. [*See* Trunkey.]
CRAVEN CREEK. [*See* Copeland.]
CRAWNEY. [*See* Murrurundi.]
CREAMY HILLS. [*See* Euabalong.]
CREMORNE. [*See* Coal Index.]
CROOKED CREEK. [*See* Parkes.]
CROOKWELL. Parish of Crookwell, county of Georgiana. M.P. 82/86; R. 17/38. *Silver.*
Assay 02/131, 03/141, 07/180. *Iron.*
County of King, 4 miles south of Crookwell. Assay 13/188. *Barytes.*
Parish of Kiamma, 6 miles north of Crookwell. M.R. No. 25, 19/234.; R. 17/18. *Gold, Limestone.*
A. 18/168. *Emery.*
CROPPA CREEK. [*See* Warialda.]
CROPPER'S LAGOON. [*See* Corona.]
CROWL CREEK. [*See* Nymagee.]
CROW MOUNTAIN. [*See* Barraba.]
CROWN RIDGE. Near Capertee.
CRUDINE. [*See* Sofala.]
CUDAL. Paling Yard Creek, parish of Bowan, county of Ashburnham, 9 miles south-east of Cudal. [*See* Orange.]
W.A. 90/268; R. 86/68, 90/74, 95/20. *Gold.*
Parishes of Bowan and Boree Nyrang. J.E.C. M.R. No. 6, 08/271, 272, 279; R. 13/82. *Copper.*
Nangar Range, parish of Nangar, 14 miles south-west of Cudal. J.E.C. M.R. No. 6, 08/280, 283; R. 75/78, 95/20, 01/21, 07/53, 08/48. *Copper, Gold.*
Nangar Valley, parish of Murga. R. 00/21, 02/17. *Gold* (poor).
Bowan Park, Bourimbla Creek, parish of Bowan.
Malachi Hill, parish of Boree Carbonne.
Boree Creek, parishes of Cudal and Grega, county of Ashburnham, 3 miles south-east and south-west to 3 miles north-east of Cudal. [*See* Molong.] M.M. 08/170; L.J.J. 14/212; M.R. No. 25, 119, 151, 155, 158, 164, 169. *Limestone, Marble.*
CUDGEGONG AND RIVER. [*See* Gulgong and Rylstone.] Wet Swamp Creek, Ironstone Creek, north of Cudgegong River, parish of Duhgeree, county of Phillip, 2 miles north-east of Cudgegong. M.P. 82/25, 87/31; Rec. VI, pt. 4, 00/243; R. 80/96, 95/18, 18/77; Dredge, J.E.C. 99/178. *Gold.*
Cheshire Mine. Bocoble Creek, parish of Bocoble, county of Roxburgh, south of Cudgegong. J.E.C. M.R. No. 6, 08/369; R. 75/31, 80/95, 82/48, 83/32, 60, 84/63. *Gold, Silver, and Copper.*
Parish of Wells, county of Roxburgh, 3 miles west-south-west of Rylstone. J.E.C. M.R. No. 16, 12/4; R. 81/48, 83/60, 84/63. *Antimony.*
Parish of Wells, 4½ miles west of Rylstone. Rev. W. B. Clarke. Mines and Mineral Stat., 75/201; C.S.W. 84/152; J.E.C. M.R. No. 7, 13/18; E.F.P. M.R. p. 410; R. 82/48, 84/63, 95/141, 99/26. *Cinnabar.*
Cudgegong River. Rec. VI, pt. 4, 00/298, 300. *Diamonds.*

Digitized by Google

Stony Pinch, Limestone Creek, &c., parish of Tannabutta, county of Wellington, 6 miles north and north-west of Cudgegong. R. 87/58, 61, 95/18, 02/21, 01/19. *Gold.*

Carwell Creek, parish of Wells, county of Roxburgh, east-south-east of Cudgegong, and north-west in parish of Tannabutta, county of Wellington. M.P. 82/108; C.S.W. 84/152; T.W.E.D. 91/213, 214; J.B.J. Mem. G. 2, 01/139, &c.; J.E.C. 04/141; E.F.P. Iron Ore Deposits of N.S.W., 1910; R. 07/60. *Iron.*

M.P. 82/118; Assay 02/131; 07/181. *Manganese.*

Carwell Creek, parish of Wells and parish of Bocoble, county of Roxburgh, 2 to 6 miles south-east of Cudgegong, south-west of Rylstone, 2 to 4 miles west of Kandos. Parish of Clandulla, near Cumber Melon Creek, 6 miles south of Rylstone. Limestone Creek, parish of Tannabutta, county of Wellington, north-west of Cudgegong. [*See* Mudgee.] At Cudgegong on River, and east of village, parish of Dungeree, county of Phillip. T.W.E.D. 91/214; Caves, St. James' Gazette, 16/12/01; M.R. No. 25, 19/123, 128, 308, 317, 324, 339. *Limestone, Marble.*

CUDGELLICO. Lake Cudgellico, south-west of Euabalong, county of Dowling; Parliamentary papers, G.F. of N.S.W. 1873–4, p. 4–10; Rec. VI, pt. 4, 00/203; R. 75/75, 76/80, 77/87, 78/73, 84/110, 03/16, 15/13, 16/13. *Gold.*

CUGONG. Parishes of Kalinga and Julanderry, county of Cunningham, 24 miles north-west of Condobolin. J.B.J. 95/175; R. 95/30, 96/68, 01/22. *Gold.*

CULGOA. 18 miles south of Queensland Border. *Gypsum.*

CULLENBONE. [*See* Mudgee.]

CULLEN BULLEN. [*See* Coal Index and Portland.]

CULLEN'S CREEK. [*See* Rivertree.]

CULLERIN, or CULLARIN. [*See* Breadalbane.]

CULLINGA. [*See* Cootamundra.]

CULLULLA. [*See* Tarago.]

CUMBAMURRA. [*See* Harden.]

CUMBANDRY. [*See* Gulgong.]

CUMBAROONA. [*See* Albury.]

CUMBER MELON. [*See* Coal Index and Rylstone.]

CUMNOCK. [*See* Molong and Wellington.] Burgoon Creek, parish of Burrawong, county of Gordon, 13 miles north-west of Molong. L.J.J. 14/211; M.R. No. 25, 19/248. *Limestone.*

J.E.C. M.R. No. 6, 08/281; Syd. Mor. Herald, 23–8–01; R. 03/49. *Copper.*

CUNGLEBUNG. Dinner Creek, near Mount Wellington, parish of Wellington, county of Gresham, 10 miles north-east of Newton Boyd. E.F.P. 80/248, 249; R. 98/53, 99/46. *Gold.*

CUNNINGAR and CUNNINGHAM'S CREEK. [*See* Harden.]

CURIA CREEK. [*See* Mount Dromedary.]

CURLEWIS. [*See* Coal Index.]

CURRA CREEK. [*See* Tarago and Wellington.]

CURRAGH, LITTLE. Abercrombie River, 16 miles south-west of Trunkey, county of Georgiana. R. 11/16, 13/17, 14/17. *Gold.*

CURRAJONG. [*See* Parkes.] Rec. VI, pt. 4, 00/204. *Gold.*

Digitized by Google

CURRANDIDGEE. Yass District. J.E.C. M.R. No. 6, 99/83. *Copper.*

CURRANGURRA CREEK. Parish of Currangurra, county of Wellington, 13 miles east-south-east of Stuart Town.
Rec. VI, pt. 4, 00/227. *Gold.*

CURRAWANG. County of Cunningham.

CURRAWONG. Counties of Canbelego, Dowling, and Harden.

CURREEKI. [*See* Coolongolook.]

CURRICKABARK. Currickabark and Wet Creeks, parishes of Cobb and Dewit county of Hawes, between Gloucester and Nowendoc. R. 85/86 07/80, 08/87. *Copper, Gold, Silver.*

CURROCH. [*See* Braidwood.]

CURROWAN. [*See* Braidwood (McGuinness' Lode) and Bateman's Bay.]

CURROWANG. County of Argyle. [*See* Collector.] Currowong Mine.
County of Wellesley. [*See* Delegate (Corrowidgin).] Corrowong Mine.

CURROWONG. County of Forbes.

CURRUMBLA STATION. [*See* Parlaes.]

DAIRY CREEK. [*See* Bywong.]

DAIRYVILLE. [*See* Coramba.]

DALCOUTT HILL. [*See* Cargo.]

DALGETY (Buckley's Crossing.) Near Bobundra Creek, Snowy River, parish of Bobundara, county of Wallace. J.E.C. M.R. No. 6, 08/378; R. 98/68. *Malachite, Chalcopyrite, Silver, Lead.*
Parish of Arable, 10 miles north-east of Dalgety. J.E.C. M.R. No. 6, 08/388. *Copper, Silver.*
Popong Creek, head of Beloka Creek, parish of Wilson, county of Wallace, 9 to 12 miles south-west of Dalgety. W.A. 89/232; R. 98/96. *Gold, Silver, Lead.*
Little Popong, Purgatory and Stony Creeks, parishes of Napier and Matong, 17 miles south of Dalgety. J.E.C. 04/140. *Tin.*
J.E.C. M.R. No. 6, 08/378. *Fluor Spar, Barytes Copper, Silver, Lead, Gold.*

DALMORTON. [*See* Boyd River.] Parishes of Dalmorton and Nullama, county of Gresham. E.F.P. 80/248; R. 77/152, 95/29, 99/46, 03/13, 04/14, 05/13, 06/20, 10/21, 14/24, 15/21. *Gold.*
Jackass Creek. R. 98/54. *Gold.*
Quart Pot Creek, 2 miles south of Dalmorton. R. 83/111. *Gold.*
Mosquito Creek, 22 miles from Dalmorton. R. 98/53, 99/46. *Gold.*
Stockyard Creek, 10 miles south-south-east of Dalmorton. R. 98/54. *Gold.*
Sheep Station Creek. R. 11/23. *Gold.*
Mount Rea, Tower Hill. R. 95/29. *Gold.*
Mount Poole and Mount Remarkable, parish of Springbrook, 6 miles north-west of Dalmorton. R. 91/131, 92/20, 95/29; 11/23. *Gold.*

DALTON. [*See* Gunning.]

DANDAHRA CREEK. [*See* Cangai.]

DANDALOO. [*See* Tottenham.]

DANGAR'S FALLS, county of Sandon. M.P. 82/100. *Antimony.*

DANGELONG. [*See* Cooma.]

DARBALARA. [*See* Gundagai.]

DARGAL'S CREEK. Tooloom Diggings, parish of Dargals, county of Selwyn, 22 miles south-south-west of Kiandra. J.E.C. 95/120, 129; Rec. VI, pt. 4, 00/198; R. 98/40, 00/26. *Gold.*

Digitized by Google

DARGUE'S REEF. [*See* Braidwood.]

DARK CORNER. [*See* Sunny Corner.]

DAROOBALGIE. [*See* Forbes.]

DARTMOOR. [*See* Cooma.]

DAVID, MOUNT. Mount Maud. [*See* Rockley.]

DAVIESVILLE. [*See* Bodangora.]

DEEP CREEK. [*See* Munga Creek, Nambucca, and Noorooma.]

DEEPWATER. Bow Creek, Manbundi Mountain, parish of Deepwater, county of Gough, 4 miles south-east of Deepwater. E.C.A. M.R. No. 24, 16/10, 75, 192; J.E.C. and E.C.A. 18/153; R. 02/132, 13/64, 14/65, 15/60, 16/58, 59, 17/52, 86, 18/54. Assay, 16/219. *Bismuth, Molybdenite, Silver.*

Cobalt, parish of Parkes, county of Gough, 10 to 14 miles east of Deepwater. J.E.C. 97/170; M.R. No. 15, 12/54; E.F.D. M.R., p. 298. R. 98/75, 06/57, 08/59, 11/63, 12/59, 15/61, 17/54, 18/59. *Bismuth, Wolfram, Sheelite, &c.*

J.E.C. M.R. No. 14, 11/148; R. 95/59, 02/52, 03/50, 07/57, 12/53, 13/57, 14/57. Dredge, 13/31. *Tin.*

Back Creek, Ding Dong, &c., parish of Parkes. C.S.W. 83/151; J.E.C. 97/170; M.R. No. 14, 11/293; M.R. No. 15, 12/54; E.C.A. M.R. No. 24, 16/80, 81, 194; E.F.P. M.R. p. 264, 299; Papers, Gs. 00/2,245; J.E.C. and E.C.A. 18/155; R. 18/54. *Arsenic, Tin, Wolfram, Molybdenite, Bismuth.*

Angoperran, parish of Angoperran, county of Clive, 19 miles north-north-east of Deepwater. [*See* Bolivia.] E.C.A. M.R. No. 24, 16/70; R. 18/53, 84; J.E.C. and E.C.A. 18/155. *Molybdenite.*

Castle Rag, parish of Romney, county of Clive, 7 miles north of Deepwater. J.E.C. M.R. No. 6, 08/306; R. 89/106, 90/39, 12/45, 13/48. A. 96/144. *Silver, Copper.*

Parish of Farnell, 16 miles east of Deepwater. R. 14/50, 15/45. [*See* Five Bull.] *Silver.*

Stannum. [*See* Vegetable Creek.]

DELANEY'S DYKE. Parish of Dilga, county of Gordon, 15 miles north-west of Molong. C.S.W. 86/133; W.A. 88/183; J.E.C. M.R. No. 6, 08/274; R. 88/75, 81, 95/20. *Gold, Copper, Silver.*

DELEGATE (Delegete.) Craigie, parish of Hayden, county of Wellesley, 6 miles east of Delegate. R. 97/43. *Gold.*

Brown's Camp, Pipeclay Creek, &c., near Victorian Border; Black Jack Range, parish of Currowang, 6 miles north-west of Delegate. J.E.C. 97/157-161; M.R. No. 6, 08/379. *Gold, Copper.*

Black Jack Mountain, Meranbego or Marambago, parish of Merrumbulo, 24 miles north-west of Delegate. E.C.A. M.R. No. 24, 16/83; R. 11/26, 14/84. *Gold, Silver, Copper, Molybdenite.*

Hayden's Bog, &c., parishes of Delegete, Hayden, and Lawson. J.E.C. 97/157; Rec. VI, pt. 4, 00/198; R. 87/81, 98/45, 08/22. *Gold.*

Slaughter House Creek, Delegete River, Quidong, parishes of Quidong, Merriangaah and Meringo, 12 miles north of Delegate. J.E.C. 97/159; M.R. No. 6, 08/9, 374; E.F.P. M.R. p. 153; R. 86/72, 87/75, 81. M.R. No. 25, 19/328. *Silver, Lead, Copper, Limestone.*

Purgatory Creek, parishes of Napier and Matong, north of Delegate. J. E.C. M.R. No. 14, 11/283. *Tin.*

Digitized by Google

DELUNGRA. Dumboy and Sheep Station Creeks, 5 miles south-west of Delungra; Warialda Creek, north of Delungra, parish of Delungra, county of Murchison, 15 miles south-east of Warialda; Gragin Creek. M.P. 82/103; J.E.C. M.R. No. 14, 11/59, 239; R. 87/89, 99/72, 06/51, 09/12, 52, 12/53, 14/55.
Assay 04/151; 07/183. *Diamonds, Copper, Tin* (poor).
Assay 00/194, 04/151. *Bismuth, with Gold.*

DEMON CREEK. [*See* Timbarra.]

DEMONDRILLE. [*See* Harden.]

DENISON. [*See* Moonan Brook.]

DENISON TOWN (Leadville). [*See* Dunedoo.]

DENMAN. Parish of Althorpe, county of Durham. J.E.C. 03/125. *Gold.*

DENT'S CREEK. [*See* Coal Index.]

DERRA DERRA MOUNT. [*See* Bingara.]

DERRINGULLEN CREEK. [*See* Yass.]

DEUA RIVER. [*See* Benditherа.] County of Dampier. R. 75/45, 00/19, 11/24, 14/26, 18/16. *Gold.*

DIAMOND HILL. [*See* Oberon.]

DIAMOND SWAMP. [*See* Tarana.]

DIGGER'S CREEK. [*See* Cangai and Mittagong.]

DIGMAN'S TANK. Parish of Tulgong, county of Flinders. *Gold.*

DIGNAM'S CREEK. [*See* Noorooma.]

DIJOE MOUNT. [*See* Bourke.]

DILGA CREEK. [*See* Goodrich.]

DILGRY RIVER. [*See* Copeland.]

DINE DINE. [*See* Euabalong.]

DING DONG. [*See* Deepwater.]

DINGO CREEK. [*See* Vegetable Creek and Wingham.]

DINNER CREEK. [*See* Cunglebung.]

DIRTY SWAMP. [*See* Yetholme.]

DISMAL SWAMP. [*See* Boonoo Boonoo.]

DOCTOR'S CREEK. [*See* Bingara.]

DOCTOR GEORGE MOUNTAINS. [*See* Bega.]

DODGER BRUSH. [*See* Uralla.]

DOG TRAP. [*See* Bungonia and Tuena.]

DOHERTY'S HILL. [*See* Uralla.]

DOLONDONDALE. Parish of Dolondundale, county of Dampier. R. 91/91. *Gold.*

DONKEY HILL. [*See* Moruya.]

DONKEY HILL RANGE, Adelong.

DORA DORA. [*See* Basin Creek.]

DORADILLA. Parish of Mulholland, county of Cowper, 30 miles south-east of Bourke. J.E.C. M.R. No. 6, 08/216, 17/158; R. 05/14, 06/45, 07/51, 10/47, 12/48, 16/47, 18/93. *Gold, Copper.*

DORRIGO. Parish of Allen, county of Fitzroy, 12 miles north of Dorrigo. J.E.C. M.R. No. 16, 12/30; A. 06/178. *Antimony.*
Moleton, eastern Dorrigo. R. 16/20. *Gold.*

DOUBLE PEAK. [*See* Mount Hope.]

DOUBLEDUKE MOUNT. County boundary, Clarence and Richmond. *Gold.*

DOUDLE'S FOLLY CREEK. [*See* Mittagong.]

DOUGHBOY HOLLOW. [*See* Coal Index.]

Digitized by Google

DOUGHBOY CREEK. [*See* Wellington.]

DOUGLAS PARK. Assay 04/153; M.R. No. 25, 19/214. *Limestone.*

DOYLE'S BROOK. [*See* Nimmitabel.]

DRAKE and Fairfield. Sawpit Gully, Mount Carrington, Ti-Tree, Violet and Yellow Creeks, &c., parishes of Drake, Fairfield, and West Fairfield, county of Drake; parish of Cavendish, county of Clive. T.W.E.D. 86/158, 159; C.S.W. 89/199; E.C.A. 03/132; M.R. No. 12, 1908; M.P. 83/102; R. 87/98, 88/109, 90/117, 93/23, 94/5, 95/28, 82, 97/47, 98/50, 99/43, 65, 00/31, 01/29, 31, 51, 02/22, 03/19, 04/20, 43, 05/15, 06/43, 07/22, 09/20, 44, 11/22, 12/20, 44, 13/22, 14/23, 50, 15/20, 46, 16/20, 17/17, 18/16. *Gold, Silver.*

Parishes of West Fairfield, Hamilton, and Ewingar, county of Drake; parish of Girard, county of Buller; Kyloe or Kyloo, Sawpit Gully, Adeline Mine, &c. C.S.W. 89/199: J.E.C. M.R. No. 6, 08/189, &c. R. 88/109, 99/69, 06/48, 07/54, 08/49, 09/49, 10/48, 11/54, 12/50, 13/53, 14/54, 88, 15/50, 16/49, 50, 17/48, 18/40. *Copper.*

Lunatic, parishes of Antimony and Jenny Lind, county of Buller, 6 miles north-west and 8 miles north of Drake. C.S.W. 89/200; J.B.J. 96/126, E.C.A. M.R. No. 12, 08/38; J.E.C. M.R. No. 16, 12/3, 40; M.P. 82/100; R. 75/50, 57, 77/113, 78/131, 99/44, 01/31, 05/16, 11/22. Assay 06/178. *Gold, Antimony.*

Long Gully, Emu and East Creeks, parish of Jenny Lind, county of Buller, 12 miles north-east of Drake. R. 04/21, 05/16, 08/19, 09/20, 10/21, 15/20, 16/20. *Gold.*

Red Rock, parish of Callanyn, county of Buller, 9 miles north of Drake. T.W.E.D. 86/159; C.S.W. 89/200; E.C.A. M.R. No. 12, 1908; R. 87/97, 99, 88/110, 113, 11/22, 13/54, 15/50; R. 16/50, 17/43, 18/40. *Gold, Silver, Copper.*

R. 03/44. *Zinc.*

Mount Rossiter, White Rock, 3 miles west and south-west of Fairfield, county of Drake. C.S.W. 89/200; E.C.A. M.R. No. 12, 1908; R. 87/97, 88/109, 90/116, 91/44, 03/44, 05/15, 06/43, 07/47, 08/47, 09/44, 10/21, 13/48, 17/39. *Gold, Silver, Zinc.*

Slaty Creek, parish of Girard, county of Buller, 7 miles west of Drake. R. 76/115. *Gold.*

Pretty Gully or Farley, parishes of Ellerslie and Jenny Lind, county of Buller, 15 miles north of Drake. C.S.W. 89/201; E.F.P. 03/124; M.R. p. 17; R. 05/16, 06/20, 07/22, 11/22. *Gold.*

Mosquito Creek, Pretty Gully, Jenny Lind Creek, &c. J.E.C. M.R. No. 16. 12/30, 31, 40. *Antimony.*

J.E.C. M.R. No. 7, 13/17, 41. *Mercury.*

Paddy's Flat, Clarence River, 6 miles north-west of Pretty Gully. *Gold.*

Rocky River, parish of Bloxsome, county of Clive, south of Drake. Dredge 18/21. *Gold.*

Plumbago Creek, near Timbarra, parish of West Fairfield, county of Drake. M.P. 82/122. *Plumbago.*

Parish of Emu, 9 miles north-east of Drake. M.R. No. 25, 19/222. *Limestone.*

Black Creek, 12 miles east of Drake. Assay 04/153, 07/181. *Limestone.*

DRIPSTONE. [*See* Wellington.]

DROMEDARY CREEK and MOUNT. [*See* Mount Hope and Nooroomа.]

DROUBALGIE. [*See* Forbes.]

Digitized by Google

Dry Creek. [*See* Moonan.]

Drysdale Mount. Mount Billagoe, parish of Moquilamba, county of Robinson, 25 miles north of Cobar. J.B.J. 94/145, 95/176; E.F.P. M.R. p. 52; R. 87/108, 88/124, 89/126, 91/141, 93/24, 66, 94/32, 95/29, 96/36, 00/34, 102, 01/32, 90, 95/13, 06/11, 95, 07/13, 91, 09/107, 11/10, 13/105, 14/101; Bores 07/74, 08/74. *Gold, Silver.*

Yanco Creek, south of Mount Billagoe. R. 29/68. *Gold.*

Dubbo. [*See* Coal Index.] Ballimore, Talbragar River, parish of Erskine, county of Lincoln, 18 miles north-east of Dubbo. E.F.P. 80/243; C.S.W. 86/138; W.A. 88/184, 187; E.F.P. M.R. p. 448; M.P. 82/107, 115; R. 82/43, 84/65, 85/57, 88/71, 90/69; A. 87/47. *Coal, Iron, Mineral spring.*

J.B.J. 95/177; Rec. VI, pt. 4, 00/243. *Gold.*

Parish of Barbigal, 15 miles north-east of Dubbo. R. 07/20. *Iron and Coal.*

Talbragar River, parish of Beni, 10 miles north-east of Dubbo. J.E.C. M.R. No. 14, 11/280; R. 07/183. *Tin, Platinum* (poor).

Parish of Daley, county of Lincoln; parish of Burrabadine, county of Narromine, W., 12 miles north-west, 4 to 17 miles east of Dubbo. R. 92/49, 96/144, 08/60, 09/60, 14/65, 15/64, 16/63, 17/57, 18/65. *Pigments.*

Macquarie River Dredge. 06/26. *Unsatisfactory.*

The Springs, Obley Road, parish of Roche, county of Gordon, 20 miles south of Dubbo. R. 13/19, 15/18, 64. *Gold.*

Hyandra Creek, parish of Oxley, county of Gordon, 13 miles south of Dubbo. R. 04/51. *Opal* (doubtful).

Duck Creek. Auburn. M.R. No. 25, 19/214. *Limestone.*

Duckholes Creek. [*See* Bingara.]

Duckmaloi Creek. [*See* Oberon.]

Dudley Mount. [*See* Trunkey.]

Dulah. Parish of Dulah, county of Bourke, 20 miles south-east of Ardlethan. R. 15/85. *Tin.*

Dumaresq River. Parish of Perth, county of Clive. 20 miles north of Emmaville. M.R. No. 25, 19/214. *Limestone.*

Dumbidgery Creek. [*See* Gordonbrook.]

Dumboy Creek. [*See* Delungra.]

Dunbible. [*See* Murwillumbah.]

Dundee. [*See* Glen Innes.]

Dun Dun Creek. (Near Hargraves.) *Gold.*

Dunedoo. Talbragar River.

Leadville, Mounts Gladstone, Scott, Stewart, &c., parish of Talbragar, county of Bligh, 8 miles east of Dunedoo. C.S.W. 87/145; T.W.E.D. 91/214; J.B.J. Mem. G. 2. 01/123; J.E.C. 16/201; M.R. No. 6, 08/296; Rec. VI, pt. 4, 00/322; R. 90/68, 91/78, 05/42, 08/42, 11/48, 12/44, 13/47, 14/49, 53, 15/45, 86, 16/44, 17/39, 18/78. *Silver, Lead, Copper, Zinc, Gold, Iron, Sulphur.*

J.E.C. M.R. No. 6, 08/297; M.R. No. 25, 19/196. *Limestone.*

J.E.C. and E.C.A. 16/201. Report on *Superphosphates.*

Limestone Creek, Talbragar River, parish of Belaro, county of Lincoln, between Dunedoo and Cobborah. M.R. No. 25, 19/264. *Limestone.*

Craboon, Cranky Jack's Gully, Birriwa, near Leadville; Sawpit Gully, Wargundy. R. 95/18, 99/25, 13/19, 14/20, 15/18 *Gold.*

Digitized by Google

Parish of Rouse, 3½ miles west of Birriwa. M.R. No. 25, 19/195. *Limestone.*

Coolah, Pine Ridge, and Mt. Laut, parish of Bullinda, county of Lincoln, north and north-west of Leadville. J.E.C. 99/130; M.R. No. 6, 08/290, 292, 294; R. 98/31, 01/55, 06/47, 07/52, 13/52, 16/48, 17/42. *Copper.*

Pine Ridge. R. 10/52. *Gold and Gems.*

Narangarie River and Range, Bowenbong or Bong Bong Creek, Mt. Scott, &c., parish of Narangarie, county of Napier, 10 miles north-east of Dunedoo. J.E.C. M.R. No. 6, 08/289; R. 82/49, 83/34, 60, 89/64. *Copper, Silver, Gold.*

R. 89/64; Papers Misc. 10/5517. *Diamonds.*

Assay, 12/196, 16/220. *Hematite.*

Talbragar River, parish of Wargundy, county of Bligh. R. 16/18. *Gold.*

DUNGEREE. [*See* Cudgegong and Lue.]

DUNGAY CREEK. [*See* Kempsey.]

DUNGOG. Parish of Dungog, county of Durham. R. 95/26. 80/181, 94/29, 02/17, 13/23, 14/24. *Gold.*

Cherry Tree Hill and Creek, parish of Thalaba, county of Gloucester, 4 miles east of Dungog. R. 79/186, 95/26. *Gold.*

Lawler's Creek. R. 95/26, 15/22. *Gold.*

R. 78/89, 186. *Silver with Gold.*

J.E.C. M.R. No. 7, 13/17. *Mercury.*

Assay, 02/131. *Manganese.*

Limestone Creek, parish of Underbank, county of Durham, 10 miles west of Dungog. Parish of Dungog, 5½ miles west of Dungog. Parishes of Lewisbrook and Avenal, 5 miles north-east of Gresford, 8 miles west of Dungog. M.R. No. 25, 19/228, 229. *Limestone.*

DUNGOWAN. [*See* Nundle.]

DURAL. [*See* Armidale.]

DWYER'S CREEK. [*See* Moruya.]

EAGLEHAWK GULLY. [*See* Windeyer.]

EAGLEHAWK CREEK. [*See* Bingara.]

EAST CREEK. [*See* Drake.]

EAST MAITLAND. [*See* Coal Index.]

C.S.W. 84/151. *Iron in Coal Measures.*

EDEN. County of Auckland.

North side of township. E.C.A. M.R. No. 24, 16/84. *Molybdenite.*

36 miles north-west of Eden. J.E.C. 96/107. *Copper.*

R. 14/27; Rec. VI, pt. 4, 00/199. *Gold.*

M.P. 82/100, 122. *Antimony, Plumbago.*

EDGECOMBE MOUNT. Blue Mountains. R. 83/35, 36. *Iron.*

EGLINTON. [*See* Bathurst.]

ELDORADO. [*See* Orange.]

ELLENBOROUGH. [*See* Hastings River.]

30 miles west of Port Macquarie. M.P. 82/118; R. 80/155. *Gold, Manganese.*

ELMSMORE. [*See* Tingha.]

Digitized by Google

ELONG ELONG. Spicer's Creek. [*See* Coal Index.]

ELOUERA. North-west of Cobar. [*See* Cobar.]

ELRINGTON. [*See* Major's Creek.]

ELSMORE. [*See* Tingha.]

EMMAVILLE. [*See* Vegetable Creek.]

EMU CREEK. [*See* Drake and Grenfell.]

EMU SWAMP. [*See* Orange.]

ENDRICK RIVER. [*See* Ettrema.]

ENMORE. [*See* Bora Creek.]

EPHRAIM MOUNT. [*See* Nundle.]

EREMERAN. County of Blaxland, 36 miles north of Euabalong. L.Y. 80/260; M.P. 82/102. *Tin.*

EREMERAN RANGE. J.E.C. M.R. No. 15, 12/56; E.F.P. M.R. p. 300. *Wolfram.*

ERIBENDERY. [*See* Euabalong.]

ERITH. [*See* Coal Index.]

ESKBANK. [*See* Coal Index.]
J.B.J. Mem. G. 2, 01/107; E.F.P. M.R. p. 196; M.P. 82/112; R. 75/140. Assay 83/37. *Iron.*

ESK RIVER. [*See* Woodburn.]

ESSINGTON. [*See* Oberon.]

ETTREMA CREEK. Parishes of St. George and Quiera, county of St. Vincent, 8 miles north-west of Sassafras and Endrick River, south-west of Sassafras. [*See* Yalwal.]
J.E.C. M.R. No. 6, 08/336, 345, 413; H. I. Jensen, Roy. Soc. N.S.W., Vol. XLII, 1908, p. 306; L.F.H. Mem G. 7, 15/274; R. 07/46, 08/41, 09/43, 10/43, 11/47, 14/47. *Silver, Copper, Lead, Zinc.*
Assay, 07/176. *Arsenic.*

EUABALONG. Parish of Creamy Hills, county of Blaxland, north of Euabalong. R. 90/29, 91/140.
Dine Dine, Tallebung and Urambie, parish of Eurambie East, county of Blaxland, 25 miles north of Euabalong. J.E.C. M.R. No. 14, 11/273; R. 00/60, 104, 07/58, 65, 183, 09/53, 10/52, 11/58, 102, 12/54, 81, 13/59, 14/59, 87, 15/54, 16/54, 17/47, 18/46. *Tin.*
R. 95/30. *Gold.*
Mount Tallebung. J.E.C. M.R. No. 15, 11/61 *Wolfram.*
A. 14/214. *Barytes.*
Eribendery, near and south of Euabalong. R. 95/30, 92/21. *Gold.*
Lachlan River, north-west of Euabalong. J.E.C. 97/171. Parish of Eurambie East. *Wolfram.*
Marobee, parish of Marobee, 36 miles north of Euabalong. J.E.C. M.R. No. 15, 12/61, 83; R. 09/59. *Sheelite.*
Mount Wilga, parish of Brotheroney, county of Dowling, 15 miles east of Euabalong. R. 95/30, 96/68, 13/13. *Gold.*

EUBINDAL. [*See* Binalong.]

EUCHAREENA. [*See* Stuart Town.]
Parish of Trudgett, county of Wellington. J.B.J. 04/70; J.E.C. 05/144; R. 04/25, 05/42, 17/15; Dredge, 11/28. *Gold, Silver.*

EUCUMBENE RIVER. Rec. VI, pt. 4, 00/198. [*See* Kiandra.]

Digitized by Google

EUGOWRA. Eurow Mountains, parish of Wise, county of Ashburnham, 8 miles north of Eugowra. J.E.C. M.R. No. 6, 08/274, 283: R. 75/37, 83/65, 91/89, 98/70, 02/50. *Copper, Gold, Silver.*
Assay, 03/141, 04/152. *Manganese.*

EULAH CREEK. [*See* Narrabri.]

EULO. [*See* Swamp Oak.]

EUMERALLA. Gulgong Division. R. 17/48. *Diamonds.*

EUMUR CREEK. [*See* Barraba.]

EURAMBIE (Urambie). [*See* Euabalong.]

EURIMBULA. [*See* Molong.]

EURIOWIE. Parish of Byjerkerno, county of Farnell, 34 miles north of Broken Hill. C.S.W. 87/138, 141; J.B.J. Mem. G. 5, 94/130; J.E.C. M.R. No. 14, 11/245, 252, 256; E.F.P. 01/159; M.R. p. 147; R. 99/73, 02/53, 03/51, 06/53, 72, 10/52, 11/58. *Tin.*
R. 98/101. *Copper.*
Rec. IV, pt. 1, p. 20. *Diamonds.*
Kantappa, parish of Corona, county of Farnell, 10 miles west of Euriowie. J.E.C. M.R. No. 14, 11/254. *Tin.*
Fairy Hill, parish of Gairdner's Creek, county of Mootwingee, 12 miles south-east of Euriowie. J.E.C. M.R. No. 6, 08/96, 99. *Copper.*
Parishes of Caloola and Byjerkerno, county of Farnell, parishes of Caloola and Bomgadah, county of Mootwingee, 36 miles north of Broken Hill. M.R. No. 25, 19/232. *Limestone.*

EUROKA. [*See* Caragabel River.]

EURONGILLY. [*See* Junee.]

EUROPAMBULA. [*See* Walcha.]

EUROW. [*See* Eugowra.]

EURUNDURY. [*See* Mudgee.]

EUSDALE CREEK. [*See* Yetholme.]

EVANS' HEAD. [*See* Ballina.]

EVEREST MOUNT. [*See* Top Bingara.]

EWINGAR. [*See* Lionsville.]

EXCELSIOR. [*See* Capertee.]

FAIRFIELD. [*See* Drake.]

FAIRY HILL. [*See* Euriowie.]

FAIRY MEADOW. [*See* Bungendore.]

FALLS, THE. [*See* Walcha.]

FARLEY. [*See* Coal Index.]

FARNHAM. [*See* Stuart Town.]

FARQUHAR'S CREEK. [*See* Coal Index.]

FELLED TIMBER CREEK. County of Georgiana, 12 miles south-east of Burraga. R. 99/23. *Copper, Gold.*

FELL TIMBER CREEK. Parish of Somers, county of Bathurst. R. 99/23. *Gold.*

FELSTEAD MOUNT. [*See* Cootamundra.]

FELTON'S CREEK. Parish of Kunderary, county of Vernon. *Tin.*

FERNBANK. [*See* Nerrigundah.]

FERNBROOK. [*See* Limekilns.]

FERNDALE. [*See* Coal Index.]

FIERY CREEK. [*See* Umaralla.]

Digitized by Google

FIFIELD. Platina, parish of Murga, county of Cunningham, 3 miles south-east of Fifield, 28 miles north-north-east of Condobolin. M.M. 18/161; R. 98/34, 02/19, 10/12, 56, 11/12, 68, 12/59, 13/61, 14/61, 87, 15/59, 17/52, 76, 18/52, 77. *Gold, Platinum.*

Parish of Murga, county of Cunningham, parishes of Tout and Gillenbine, county of Kennedy. J.B.J. Rec. V, pt. 1, 1896; E.F.P. M.R. p. 82; J.A.W. 98/172; R. 93/63, 65, 94/32, 00/56, 03/66, 04/54, 05/53, 06/58, 07/63, 08/59, 09/57, 10/56, 12/12, 13/13, 14/13, 15/12, 16/12. *Gold and Platinum.*

Burra Burra, parish of Burra, county of Kennedy, parish of Corella, county of Cunningham, 10 miles north-west of Fifield. J.E.C. M.R. No. 14, 11/274; R. 01/55, 05/48, 10/12, 11/12. *Gold, Platinum.*

Parish of Burra, county of Kennedy. J.B.J. 95/181; J.E.C. M.R. No. 14, 11/272, 275; E.F.P. M.R. p. 147; R. 93/65, 95/30, 01/58, 04/52, 06/52, 07/58, 08/53, 10/51, 11/53. *Tin.*

Murrumbogie, parish of Murga, county of Cunningham, south of Fifield. *Gold, Tin.*

Parish of Tout, county of Kennedy, 3 to 6 miles north-west of Fifield. J.B.J. 07/75; R. 07/181, 182, 08/61, 09/60, 11/66, 102, 12/62, 14/67, 15/62, 16/62, 17/55, 18/63, 77. *Magnesite.*

Assay 14/214, 16/219, 12 miles north-west of Fifield. *Gold, Silver, Bismuth.*

Tullamore, Lightning Paddock, parish of Yralla, county of Kennedy, 14 miles north of Fifield. R. 01/55, 11/103. *Copper.*

9 miles west of Tullamore. Assay 16/220. *Magnetic Iron.*

Bursted Boulder, parish of Tout, north-west of Fifield, parish of Gillenbine, 4 miles north of Fifield, county of Kennedy. P.T.H. 92/170; J.B.J. Mem. G. 2, 01/123; R. 05/20, 13/66; Assays 07/81, 12/196, 197; M.R. No. 25, 19/259. *Iron, Limestone.*

Tigers Camp Creek, above the Washpool, parish of Talingaboolba, county of Kennedy, 28 miles north-west of Fifield. M.R. No. 25, 19/259. *Limestone.*

FINE FLOUR CREEK. [*See* Gordonbrook.]

FISHER MOUNT. [*See* Mulloon.]

FISH RIVER. [*See* O'Connell.] E.F.P. M.R. p. 1. Near platform east of Gunning. *Gold.*

FITZGERALD VALLEY. Queen Charlotte Vale Creek, 13 miles south-south-west of Bathurst. Dredge 05/26, 06/26; R. 87/83. *Gold.*

FITZROY. [*See* Mittagong.]

FITZROY BAR. [*See* Ophir.]

FIVE BULL. Morven Creek, parish of Farnell, county of Clive, north of Glen Elgin, 25 miles south-east of Tenterfield. R. 99/45, 01/31, 12/44, 14/50, 15/45. *Gold, Silver.*

FLAGGY CREEK. [*See* Waratah, Coal Index. *See* Vegetable Creek.]

FLAGSTONE CREEK. [*See* Vegetable Creek.]

FLORIDA. [*See* Canbelego.]

FLYERS CREEK. [*See* Carcoar and Orange.]

FOLEY'S FOLLY. [*See* Nundle.]

FONTANA REEFS. [*See* Bathurst and Winburndale.]

Digitized by Google

FORBES. Bald Hills, &c., parishes of Forbes and Dowling, county of Ashburnham. Parliamentary papers G.F. of N.S.W., 1873–4; E.C.A. 09/182; M.R. No. 13, 1910; E.F.P. M.R. p. 10; Rec. VI, pt. 4, 00/203; R. 75/41, 74, 76/81, 77/75, 82, 79/89, 96, 83/64, 95/20, 98/32, 99/27, 00/21, 01/21, 79, 02/17, 03/15, 04/15, 05/18, 06/12, 07/14, 08/12, 11/12, 12/11, 13/12, 14/13, 87, 15/12, 16/12; Bores 05/76. *Gold.*

Daroobalgie, 8 miles north of Forbes. J.E.C. 94/118; R. 06/12. *Gold.*

Assay 04/152. *Manganese.*

Iron Bark Reef, Wondoorangan Creek or Back Creek, The Pinnacles, &c., parishes of Boyd and Currowong, county of Forbes, 18 miles south-south-west of Forbes. R. 76/57, 78/73, 82/52, 87/62, 96/28, 97/33, 98/34, 99/28, 02/18, 05/18, 06/12, 08/12, 09/11. *Gold.*

Calarie. R. 17/11. *Gold.*

Rifle Range, parish of Forbes, north of Forbes, parishes of Mumbidgle and Bocobidgle, county of Ashburnham, 3 to 8 miles north-west of Forbes. M.R. No. 25, 19/153, 167, 172. *Limestone.*

FORD'S CREEK. [*See* Gulgong and Cobborah.]

FOREST REEFS. Carbine Paddock, west of Brown's Creek, parishes of Benerce and Calvert, county of Bathurst, between Carcoar and Orange. H.Y.L.B. 82/140; E.F.P. 99/160; J.C.H.M. 06/176; M.P. 82/25; R. 94/5, 97/12, 99/24, 04/12, 05/11, 06/16, 07/18, 08/16, 10/16, 11/16, 15/86, 16/15, 84; Bores 97/90. *Gold.*

Sugarloaf Hill, Slattery's Creek, parish of Calvert, 3 miles south of Forest Reefs; M.R. No. 6, 08/169; R. 95/16, 09/47. *Copper, Gold.*

Gooley's Creek, parish of Beaufort. R. 04/13. *Gold.*

Parish of Errol, north of Carcoar. H.Y.L.D. 82/140. *Iron.*

FOREST, THE. 6 miles west-south-west of Milthorpe. R. 76/58. *Gold.*

FOUR MILE CREEK. [*See* Bingara, Cadia, Coppabella, Holbrook, and Lucknow (and Maitland under Coal Index).]

Narrandera Division. *Gold.*

FOUR MILE RUSH. [*See* Gilgunnia.]

FRASER, MOUNT. [*See* Byng.]

FRASER'S GULLY. [*See* Ashford and Tooloom.]

FREDERICK'S VALLEY CREEK. From Lucknow to Ophir. [*See* Ophir and Orange.] *Gold.*

FRENCHMAN'S CREEK. Springbrook, 4 miles west of Dalmorton. *Gold.*

FROGMOOR. [*See* Boorowa.]

FROME, MOUNT. [*See* Mudgee.]

FURRACABAD. [*See* Glen Innes.]

GADARA. Between Adelong and Tumut, county of Wynyard. R. 94/5. *Gold.*

GAHAN, MOUNT. [*See* Pambula.]

GAIRDNER'S CREEK. [*See* Euriowie.]

GALAMBINE. 10 miles west of Mudgee. *Gold.*

GALENA, MOUNT. [*See* Wellingrove.]

GALLAGHER'S PLAINS. [*See* Bombala.]

GALLYMONT. [*See* Mandurama.]

GALLY SWAMP. [*See* Mandurama.]

GALONG. [*See* Binalong.]

GALWADGERE (Galwadgery.) [*See* Wellington.]

Digitized by Google

GAMBOOLA ESTATE. [*See* Molong.]
GANMAIN. [*See* Grong Grong.]
GAP CREEK. [*See* Cangai.]
GAP RANGE. Between Emmaville and Tent Hill, and 1 mile north-east of Adelong. [*See* Nundle and Lithgow.] *Tin, Gold.*
GARA FALLS or Gyra. [*See* Hillgrove.]
GARANGULA. [*See* Harden.]
GARIBALDI GULLY. [*See* Newbridge.]
GARRA. [*See* Molong.]
GARRYOWEN. [*See* Wellington.]
GEMVILLE. [*See* White Cliffs.]
GENOWLAN. [*See* Coal Index.]
GEORGE, MOUNT. [*See* Noorooma.]
GEORGE'S PLAIN RAILWAY STATION. [*See* Rockley.] A. 18/168. *Soapstone.*
GERMANTON. [*See* Holbrook.]
GEROGERY. Parish of Gerogery, county of Goulburn, 2½ miles east of Railway Station. M.R. No. 25, 19/250. *Limestone.*
GEURIE. [*See* Wellington.]
GIANT'S DEN. [*See* Bendemeer.]
GIBBERGUNYAH CREEK. Junction with Nattai River, county of Camden. C.S.W. 90/209. *Iron.*
GIBRALTAR. [*See* Adelong.]
Range between Timbarra and Mann River, counties of Drake and Clive. R. 75/109. *Tin.*
GIFFORD MOUNT. [*See* Lankey's Creek.]
GILGAI OR GILGHI CREEK. [*See* Tingha.]
GILGUNNIA. Tarcombe Peak, &c., parishes of Gilgunnia, South Peak, and Tarcombe, county of Blaxland, 32 miles north of Mount Hope. J.E.C. M.R. No. 6, 08/217, 248. *Copper.*
East of South Peak Mountain. J.B.J. 96/136; R. 95/30, 84, 96/37, 99/48, 00/34, 01/90, 02/17, 03/14, 04/13, 05/13, 06/11, 07/13, 08/11, 09/11, 13/12, 14/12, 101. *Gold.*
Salt Creek, 18 miles south of Gilgunnia. R. 07/51. *Copper.*
Parish of Marobee, 25 miles east-south-east. M.R. No. 25, 19/194. *Limestone.*
GILLENDICH. [*See* Junction Point.]
GILMANDYKE. [*See* Rockley.]
GILMORE CREEK. [*See* Tumut.]
GILMORE VALLEY. [*See* Batlow.]
GINEROI. North-west of Bingara. M.P. 82/100. *Antimony.*
GINKIN. South of Oberon. R. 14/18. *Gold.*
GINNINDERRA. Parish of Ginninderra, county of Murray. R. 98/40. *Gold.*
GIRARD'S CREEK. [*See* Boorook.]
GIRILAMBONE. Parishes of Gidalambone and Wilgabone, county of Canbelego. L.Y. 80/262; J.E.C. M.R. No. 6, 08/217, &c.; E.F.P. M.R. p. 171; M.P. 82/26; R. 80/43, 84/120, 05/44, 06/45, 94, 07/50, 91, 08/45, 10/97, 13/104, 17/91. *Copper.*
Girilambone. R. 03/14. *Gold.*
3 miles west. *Iron.*
GLANMIRE. [*See* Bathurst.]

Digitized by Google

GLASSON'S PADDOCK. Near Blayney. *Copper, Gold.*

GLEN ALICE. [*See* Coal Index and Capertee.]

GLENBROOK. [*See* Berridale.]

GLENCOE. [*See* Glen Innes and Mount Mitchell.]

GLEN CREEK, or Beardy River. [*See* Vegetable Creek.]

GLENDALE. [*See* Tingha.]

GLENDON. 15 miles north-east of Glen Innes. R. 09/52, 11/57. *Tin.*

GLENDONBROOK. [*See* Coal Index.]

GLEN EDEN. [*See* Glen Innes.]

GLEN ELGIN. Rocky River, parishes of Binny, Garrett and Glen Elgin, county of Clive, 20 miles east-north-east to 30 miles north-east of Glen Innes. J.E.C. M.R. No. 14, 11/289, 336; R. 75/111, 89/108, 95/26, 14/23; Dredge 02/31, 03/30, 04/30, 05/47, 06/27. *Gold, Tin.*

R. 18/60. *Wolfram.*

Parish of Robertson, county of Gough, south of Glen Elgin. R. 12/44. *Silver, Copper.*

Parish of Lewis, south-west of Glen Elgin, parish of Farnell, county of Clive, north of Glen Elgin. [*See* Pheasant Creek.] E.C.A. M.R. No. 24, 16/88, 89. *Molybdenite.*

GLEN INNES. County of Gough. Glen Eden, Dundee, and Hogue's Creek, Severn River, parishes of Boyd and Severn, 12 to 14 miles north-east of Glen Innes. G.A.S. 93/116; E.F.P. M.R. p. 130; J.E.C. M.R. No. 14, 11/289, 294; M.P. 82/27; R. 75/110, 76/116, 18/43; Dredge 17/22. *Tin.*

Furracabad, north-west of Glen Innes. R. 75/111. *Tin.*

Grafton Road, parish of Bloxsome, county of Gough. 16 miles from Glen Innes. J.E.C. M.R. No. 14, 11/289, 294, 336; Dredge 17/22; R. 17/43. *Tin.*

Shannon Vale, Beardy Waters, Mitchell or Mann Rivers, parishes of Beardy Plains, Rusden, Boyd, and Stonehenge, Skeleton Creek, parishes of Bald Nob and Mitchell, Lamb's Valley, &c., east, north, and north-east of Glen Innes. G.A.S. 95/165; J.E.C. 96/101; M.R. No. 14, 11/293, 294, 295, 335; R. 75/109, 76/116, 95/59, 00/59, 05/47, 06/51, 12/53, 13/56, 14/57, 15/53, 16/52, 17/45; Dredge 06/27, 12/27, 13/30, 18/19, 43, 14/31, 15/28, 17/21, 18/19, 43. Blair Hill, 9 miles south-east. M.P. 82/103; R. 00/59. *Tin.*

Glen Innes Common. R. 16/44, 17/17, 39. *Gold, Silver.*

Bald Nob, parish of Bald Nob, 12 miles north-east of Glen Innes. R. 91/114, 15/50. Grafton Road R. 85/12. *Copper.*

R. 89/106, 13/48. *Silver.*

Fladbury. R. 18/62. *Arsenic.*

R. 18/60. *Wolfram.*

Oakwood and The Gulf, east of Mitchell River. R. 75/111. *Gold.*

Baker's Hill, Glen Eden, parish of Boyd, 12 miles north-east of Glen Innes. C.S.W. 83/154; E.C.A. M.R. No. 24, 16/85, 89; R. 18/53.

Parish of Llanglothlin, 3 miles south of Glencoe, 15 miles south of Glen Innes; E.C.A. M.R. No. 24, 16/119. *Molybdenite.*

Digitized by Google

Molybdenite occurs at intervals north-easterly from Glen Innes and north-easterly from Kingsgate to the north of Glen Elgin in the parishes of Boyd, Mann, Blaxsome, The Brothers, Diehard, and Parkes' county of Gough; parishes of Lewis, Farnell, and Moogem, county of Clive; E.C.A. M.R. No. 24, 1916. [*See* Mitchell, Kingsgate, Glen Elgin, Pheasant Creek, and Deepwater in the vicinity of the above.]

Glen Innes District. C.S.W. 82/28, 83/154; T.W.E.D. Mem. G. 1, 87/2; J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 265, 300; J.E.C. 97/170; M.R. No. 15, 12/57, 90; R. 05/54, 12/61, 15/61; Dundee, E.F.P. M.R. p. 130. *Bismuth, Tin, Wolfram.*

Parish of Waterloo, county of Gough, 11 miles west of Glen Innes. M.R. No. 25, 19/250. *Limestone.*

GLENKEN. Parish of Glenken, county of Selwyn, 17 miles south-west of Tumbarumba. [*See* Jingellic.] *Gold.*

GLENLYON STATION. Parish of Burke, county of Tandora, 65 miles east of Broken Hill. R. 13/97. *Copper, Silver, Lead.*

GLEN MORRISON. Parishes of Branga, St. Leonard's, and Cobrabald, county of Vernon, 15 miles south to south-west of Walcha. Rec. VI, pt. 4, 00/231; R. 75/49, 96, 76/68, 109, 88/104 95/27, 05/17. *Gold.*

GLOUCESTER. County of Gloucester [*See* Barrington A. A. Company's Grant.] Tugrabakh and Mogram Creeks, 3 miles north-north-east, 1½ to 6 miles east-north-east of Gloucester, south and west of Barrington River, parish of Fitzroy, 3 to 5 miles north-west of Gloucester, M.R. No. 25, 19/238, 239. *Limestone.*

GNALTA CREEK. Parish of Gnalta, county of Yungnulgra, 12 miles south of Nuntherungie. *Copper.*

GOBA. [*See* Batemans Bay and Boorowa.]

GOBARRALONG. Parish of Gobarralong, county of Harden, east of Coolac. R. 01/64, 02/76, 03/55, 04/54, 06/58, 07/63.
[*See* Gundagai.] *Chromite.*
Assay 16/220.

GOBONDERY RANGE. Parish of Gobondery, county of Kennedy; parish of Gillenbine, county of Cunningham, 7 miles north-east of Fifield. J.E.C. M.R. No. 6, 08/280; R. 79/88, 12/49. *Copper, Tin.*
M.P. 82/100; J.E.C. M.R. No. 16, 12/31. *Antimony.*
Parish of Gillenbine. J.A.W. 98/173; J.B.J. Mem. G2, 01/120. *Specular Iron Ore.*

GOLCONDA. [*See* Mookalimbira.]

GOLDEN GATE. 8 miles from Bingara. *Antimony.*

GOOBANG, or Billabong Creek. [*See* Parkes.]

GOOBARRAGANDRA. Parish of Goobarragandra, county of Buccleuch, 22 miles south-east of Tumut. [*See* Tumut.] R. 06/14, 14/16, 15/14, 84, 17/12. *Gold.*
Assay 06/178. *Chromite.*

GOODA CREEK. [*See* Yass.]

GOODEY CREEK, JOIR. 10 miles from Jerilderie. *Gold.*

GOOD GOOD. Rec. VI, pt. 4, 00/196. *Gold.*

GOOD HOPE. [*See* Woolgarlo.]

GOODIMAN CREEK. [*See* Gulgong.]

Digitized by Google

GOODRADIGBEE RIVER. From the Murrumbidgee River, southerly along the Goodradigbee River, parishes of West Goodradigbee and Wee Jasper, county of Buccleuch; parish of Childowla, county of Harden, 20 to 27 miles south-south-west of Yass. Includes the Goodravale and Cave Flat Caves. [*See also* Cooleman.] M.R. No. 25, 19/9, 198, 199. *Limestone.*

Cave Flat Caves, R.E., Ann. Rep. Trustees Aust. Museum for 1889; Parliamentary Papers, Caves and Rivers of N.S.W., 1882.

Goodravale Caves, Clarke's Southern Goldfields of N.S.W., p. 105; R.E. Rec. III, pt. 1, 92/37. [*See* Yass.]

Parish of Childowla, county of Buccleuch, 5 miles south-west of junction of Murrumbidgee and Goodradigbee Rivers. M.R. No. 25, 19/198. *Limestone.*

Limestone Creek, parish of Childowla, county of Harden, 5 miles north of Burrinjuck, 8 miles south of Bookham. M.R. No. 25, 19/199, 252. *Limestone.*

Limestone Creek, parish of Clive, county of Buccleuch, 4 miles south of Murrumbidgee River. M.R. No. 25. 19/198. *Limestone.*

Parish of Bimberi, county of Cowley, north-east of Cooleman. R. 82/74, 13/16, 14/16. *Gold.*

GOODRICH. [*See* Yeoval.]

GOOLEY'S CREEK. [*See* Forest Reefs.]

GOOLMA. [*See* Belara.]

GOOLONGOLOK. [*See* Coolongolook.]

GOONDAH. [*See* Bowning.]

GOONIGAL. Parish of Goonigal, county of Forbes, between Forbes and Grenfell. R. 03/16, 04/16, 87, 05/18, 79, 06/12, 07/14, 09/12. *Alluvial Gold.*

GOONUMBLA. [*See* Parkes.]

GOONOO GOONOO. South-south-west of Tamworth, county of Parry. *Gold.*

GORDONBROOK CREEK. Parish of Pucka, county of Drake, south-west of Gordon, 12 miles south-east of Lionsville. E.F.P. 79/227, 80/247; C.S.W. 89/204; J.E.C. 05/142; M.R. No. 6, 08/180, 187, 190, 193; R. 88/120, 04/47, 05/151, 06/49, 09/49, 13/54, 14/55. *Copper, Silver, Gold* (trace), *Iron, and Marble.*

R. 09/20, 10/21. *Gold.*

Pulganbar Creek, Clarence River, parish of Pulganbar, south of Gordon, north-west of Copmanhurst. J.E.C. M.R. No. 7, 13/17, 39; R. 10/58, 11/65, 12/62, 13/67, 14/67, 15/63. *Mercury.*

J.E.C. M.R. No. 6, 08/188, 192. R. 10/44, 11/55. *Copper, with Silver.*

Assay 03/140, 07/175, 178. *Cobalt, with Gold and Silver.*

J.E.C. M.R. No. 16, 12/43. [*See* Lionsville.] *Antimony.*

Parishes of Pucka and Yarrcalkiarra. T.W.E.D. 91/218; J.E.C. 97/149, 05/142; M.R. No. 1, 1898; E.F.P. M.R. p. 285; M.P. 82/114. [*See* Yugilbar under Lionsville.] *Chromite.*

Dumbidgery Creek, Clarence River, parish of Pucka, 11 miles south-east of Lionsville. *Limestone.*

GOSFORD. County of Northumberland. J.B.J. Mem. G. 2, 01/117; M.P. 82/110. Assay 16/220. *Iron.*

GOSTWICK. [*See* Uralla.]

Digitized by Google

GOULBURN. [*See* Merrilla under Breadalbane.] Baw Baw, Lockyersleigh, parishes of Baw Baw and Goulburn, county of Argyle, 4 miles west of Goulburn. J.E.C. M.R. No. 6, 08/353; R. 06/84. *Copper, Gold.*

Mummel, parish of Mummel, 10 miles west of Goulburn. J.E.C. M.R, No. 6, 08/364. Parish of Milbang. [*See* Collector.] *Copper.*

Tirranna, parish of Goulburn, 6 miles south of Goulburn. R. 11/24. *Gold.*

Mannafield, 8 miles east of Goulburn. R. 81/59. *Gold.*

Norwood, parish of Narrangarril, 6 miles north of Goulburn. *Gold.*

Cookbundoon Range, parish of Norrong; Towrang, Wollondilly River, parish of Nattery, 7 miles north-east of Goulburn. E.F.P. M.R. p. 2; R. 85/72, 87/75, 04/43. *Gold, Silver.*

Norwood, Joppa, Kingsdale, &c., parishes of Goulburn and Narrangarril. C.S.W. 84/146; J.B.J. Mem. G. 2, 01/124, 125, 133; R. 18/48. *Iron and Iron Oxide.*

Parish of Narrangarril, 2½ miles west of Towrang. K. 17/38. *Silver* (doubtful).

Tarlo Creek, parish of Upper Tarlo, 16 miles north-north-west of Goulburn. J.A.W. 97/181. *Diamonds, Gold.*

Parish of Narrangarril, 3½ miles from Towrang. E.C.A. M.R. No. 24, 16/89. *Molybdenite.*

Boxers' and Shaw's Creeks, &c., parish of Towrang, east and south-east of Goulburn. R. 16/21. *Iron, Gold.*

E.F.P. M.R. p. 434; J.B.J. 99/189; M.M. 18/161; R. 08/61, 14/68, 15/61, 16/ 63, 17/56, 18/65. *Potter's Clay.*

Wollondilly River, parishes of Baw Baw and Goulburn; Kingsdale and Norwood, parish of Narrangarril, 3 to 7 miles north; parish of Rhyana, 9 miles north; Bangalore Creek and Collector, parish of Tarago, 10 to 13 miles south-south-west of Goulburn, parish of Quialigo, 16 miles south-east. J.B.J. Mem. G. 2, 01/125; M.R. No. 25, 19/131, 138, 143, 145; R. 08/54. *Limestone.*

GOULBURN RIVER. [*See* Coal Index.]

GOURON GOURON CREEK. [*See* Upper Bingara.]

GRABINE. [*See* Mount McDonald.]

GRAFTON. [*See* Coal Index.] Beach, county of Clarence. Dredge 15/29. *Gold, Platinum.*

Tea Tree Creek, parish of Elland, county of Clarence, 7 miles south-south-west of Grafton. M.P. 82/102. *Gold, Tin.*

GRAGIN. [*See* Delungra.]

GRAHAMSTOWN. [*See* Adelong.]

GRAMPIANS. [*See* Vegetable Creek.]

GRANITE, THE. [*See* Tibboburra.]

GRANITE SPRINGS. [*See* Purnamoota.]

GRANT'S CREEK. [*See* Nambucca.]

GRASSMERE. [*See* Nuntherungie.]

GRASS TREE. [*See* Noorooma.]

GRASSY GULLY. [*See* Yalwal.]

GRATTAI. [*See* Mudgee.]

GRAVEYARD CREEK. [*See* Nerrigundah, Vegetable Creek, and Walcha.]

GREAT WATERHOLE. [*See* Ophir.]

Digitized by Google

GREEN CREEK. [*See* Braidwood.]

GREEN HILLS. [*See* Capertee.]

GREEN MANTLE. [*See* Mount McDonald.]

GREEN SWAMP. [*See* Bathurst.]

GRENFELL. Lawson's Hill, Fontana Reefs, &c., from Grenfell south-easterly, parishes of Brundah, Coba, and Tyagong, county of Monteagle. C.S.W. 76/156; R. 75/43, 78, 76/52, 77/77, 78/76, 85/60, 95/20, 98/35, 99/28, 88, 06/12, 13/13, 14/86. *Gold.*

Surprise Reefs, Bungalong Creek, 9 miles east-south-east of Grenfell. *Gold.*

Arramagong, Tyagong Creek, parish of Tyagong, 10 miles south-south-east of Grenfell. W.A. 90/266; J.E.C. M.R. No. 6, 08/269; M.P. 82/86; R. 88/76, 90/75, 12/13, 14/15. *Gold, Silver, Copper.*

Emu Creek, &c., parishes of Brundah and Coba. J.E.C. M.R. No. 14, 11/279; M.P. 82/27; R. 06/52, 181, 07/58, 13/58; Assay 06/181.

15 miles north-west of Grenfell. R. 18/77. *Tin.*

Near Grenfell. J.E.C. 97/149; M.R. No. 1, 1893; Assay 13/188. *Chromite.*

Bumbaldry, Broula King, Tyagong Creek, parish of Bumbaldry, 18 miles east of Grenfell. J.B.J. 02/127; R. 01/22, 02/19, 03/16, 04/16, 05/18, 06/12, 08/12, 09/12, 10/12, 11/12, 12/12, 15/12, 13, 16/13, 18/11. *Gold.*

J.E.C. M.R. No. 6, 08/271, 274; R. 03/48, 140, 05/45, 06/47, 08/48, 10/47, 11/53, 12/49, 13/52, 14/53. *Copper.*

Tyagong Creek, parish of Burramunda, half-way between Young and Grenfell. R. 09/14, 15/13. *Gold, Silver.*

Weddin Mountain, parish of Weddin, 8 miles south-west of Grenfell. R. 79/101, 06/12, 07/14. *Gold.*

Parish of Eualdrie, county of Forbes, west of Grenfell. R. 15/63, 16/63, 17/56, 18/63, 77. Near Grenfell and between Parties and Weddin Mountains. Assay 16/220. *Manganese.*

Parish of Bumbaldry, county of Monteagle, 15 miles east of Grenfell. R. 08/56, 15/57; M.R. No. 25, 19/276. *Limestone.*

Native Bear or Dog Creek, parish of Wallah Wallah, county of Forbes, 8 miles north-north-east of Grenfell. J.E.C. M.R. No. 14, 11/279; R. 18/10. *Gold, Tin.*

J.B.J. 99/12. Toohey's lease, 18 miles north of Grenfell. *Gold.*

GRESFORD. [*See* Dungog.] Parish of Gresford, county of Durham, 13 miles south-west of Dungog. J.E.C. M.R. No. 16, 12/3, 31; M.P. 82/100; R. 07/62. *Antimony, Limestone.*

GRETA. [*See* Coal Index.]

GREY MARE'S TAIL FALLS. Parish of Coventry, county of Clarke. *Tin.*

GREY MARES, BOGONG. Parishes of Gungartan and Jagungal, county of Selwyn, 34 miles south-south-east of Tumbarumba. R. 97/12, 15/14. *Gold.*

GREY MOUNT. [*See* Trunkey.]

GREY RANGE. [*See* Milparinka.]

GRIFFITH. Lake View Tank and Pine Vale Station; parish of Wyangan, county of Cooper; parish of Mirrool, county of Sturt. M.R. No. 25, 19/208, 327; A. 16/222. *Travertine, Gypsum.*

Digitized by Google

GRONG GRONG. [*See* Cowabbie.] Parish of Fennel, &c., county of Bourke, 9 miles north of Grong Grong. E.F.P. 93/111, 94/109,; M.R. p. 51; R. 94/26, 78, 01/24, 10/14, 11/14, 12/13, 13/14, 14/15, 15/13, 14, 16/13. *Gold.*

Mallee Hen, Murril Creek, parish of Boblegigbie, between Grong Grong and Ardlethan. R. 11/14, 15/13. *Gold.*

Parishes of Dulah and Devlin, north of Ganmain, 16 miles north-east of Grong Grong. J.E.C. M.R. No. 14, 11/298, 14/59; R. 16/53, 18/46. *Tin.*

GROSE RIVER. [*See* Coal Index.] Assay 03/139. *Bismuth, Zinc, Lead.*

GROSVENOR MOUNT. [*See* Bathurst.]

GROVE CREEK. [*See* Cargo and Trunkey.]

GULF. [*See* Mole Tableland, Vegetable Creek.]

GULF CREEK. Parish of Capel, county of Murchison, 10 miles north-east of Cobbadah. E.F.P. M.R. p. 176; J.E.C. M.R. No. 6, 08/322, 326, 328; R. 96/11, 98/70, 99/69, 01/55, 03/47, 04/46, 05/46, 06/49, 07/55, 09/50, 110, 10/49, 11/55, 14/55, 17/43, 18/41. *Copper, Iron.*

GULGANDRA CREEK. Monaro District. Monmouth Copper Mine. J.E.C. M.R. No. 6, 08/389. *Copper.*

GULGONG. Red Hill, &c., parishes of Gulgong and Guntawang, county of Phillip, and north-west, in parish of Puggoon, county of Bligh, 17 miles north of Mudgee. C.S.W. 76/167, 86/134; E.F.P. 91/208, 98/154; M.R. p. 12; M.P. 82/114; Rec. VI, pt. 4, 00/243; R. 75/31, 69, 76/44, 79, 83/57, 58, 84/60, 92/18, 95/18, 96/11, 97/30, 27, 04/19, 05/15, 06/18, 07/20, 08/18, 09/17, 11/19, 12/17, 13/19, 14/20, 15/18, 86, 16/17, 84, 17/15, 18/14, 77. *Gold.*

M.R. No. 25, 19/309. *Limestone.*

Cooyal or Reedy Creek, Cudgegong River. R. 03/18. *Gold.*

Combandry, between Wyaldra and Gulgong. R. 09/17. *Gold.*

Home Rule, Wyaldra, parish of Wyaldra. E.F.P. 00/181; L.F.H. 01/171; C. E. Murton, 03/134, Bores. Rec. VI, pt. 4, 01/243; R. 76/45, 77/73. *Gold.*

M.M. 18/161. *Pottery Clay.*

Salvation Hill, 2 miles north of Gulgong. R. 00/16, 05/14. *Gold.*

Raynors and Piambong Creeks; Yamble, parish of Biraganbil, county of Wellington, 12 miles south-west of Gulgong. R. 95/18, 98/31, 00/16, 02/21. *Gold.*

Stubbo or Stobo, parish of Stubbo, north of Gulgong. R. 17/76, 18/77. *Gold.*

Ford's Creek, 4 miles south of Gulgong, county of Phillip. C.S.W. 86/136, 87/144; J.E.C. M.R. No. 16, 12/30. Assay, 16/219 *Antimony.*

Goodiman Creek, parish of Goodiman, county of Bligh, 10 miles west of Gulgong. J.E.C. M.R. No. 16, 12/31; R. 89/66. *Antimony.*

Tallawang, parishes of Puggoon and Tallawang, county of Bligh, north-west of Gulgong. C.S.W. 86/136, 138; T.W.E.D. 91/214; J.B.J. Mem. G. 2, 01/55, 158; E.F.P. Iron ore deposits of N.S.W., 1910; L.F.H. 13/183; M.P. 82/114; R. 11/60, 12/56, 14/60, 15/55, 16/84, 17/48, 76, 18/48. Assay 04/152, 12/196. *Iron.*

Clough's Gully. E.F.P. M.R. p. 5, 17; R. 80/94, 81/48. *Gold.*

Assay, 03/141. *Manganese.*

Digitized by Google

Six miles from Tallawang Siding. R. 16/48. *Copper.*

Wyaldra. J.B.J. Mem. G. 2, 01/135, county of Phillip. *Iron, Manganese.*

Cudgegong River. C.S.W. 76/173, 86/138; T.W.E.D. 91/214. *Iron.*

Three miles south of Gulgong. J.E.C. M.R. No. 6, 08/290, 291. *Copper.*

Reedy Creek, Cudgegong River. C.S.W. 86/138. J.E.C. M.R. No. 14, 11/296. *Tin.*

Beryl, Biraganbil, parish of Biraganbil, county of Wellington; parish of Guntawang, county of Phillip, Cudgegong and Wyaldra or Reedy Creek Junction. Thompson and Taylor, Geol. Mag., 1879, VI (2), p. 399, 442, 458; Syd. M.H., 29th December, 1870; Trans. R. Soc., N.S.W., 1870, p. 94; D. C. McLachlan, Diamonds in N.S.W., 1899, p. 5; C.S.W. 86/137; E.F.P. M.R., p. 386, 412; R. 00/16. *Diamonds.*

Seven miles from Gulgong. E.C.A. M.R. No. 24, 16/90. *Molybdenite* (traces).

Home Rule, Wyaldra. L.F.H. 16/210; M.M. 18/161; R. 15/64, 16/63, 17/56. *Kaolin.*

Parish of Stubbo, county of Bligh, 7 miles north of Gulgong. M.R. No. 25, 19/195. *Limestone.*

GULPH, THE. [*See* Nerrigundah, under Noorooma.]

GUMBLE. [*See* Manildra.]

GUM FLAT. [*See* Bingara, Cargo, Inverell, and Stuart Town.]

GUNBAR. Parish of Synnott, county of Nicholson. M.R. No. 25, 19/298. *Travertine.*

GUNDAGAI. Murrumbidgee River, Mount Parnassus, Kimo Range, Reno, Jones Creek, parishes of North Gundagai and Kimo, county of Clarendon, Jackalass, parish of South Gundagai, county of Wynyard. T.W.E.D. 90/230; E.F.P. 89/161, 00/179; M.R., p. 63; J.E.C. 98/160; L.F.H. 15/187; Rec. VI, pt. 4, 00/234; R. 84/86, 90/93, 93/22, 95/22, 96/11, 29, 97/34, 98/35, 99/29, 00/22, 01/23, 87, 02/19, 03/16, 17, 74, 04/16, 05/19, 06/12, 07/14, 08/12, 09/12, 10/12, 11/12, 12/12, 13/13, 14/13, 86, 15/12, 16/12, 82, 17/88; Dredge, 13/29, 14/30, 16/25; Bore, 01/91. *Gold.*

Long Tunnel Mine. L.F.H., 1919. R. 17/11, 18/11. *Gold.*

Kimo. M.R. No. 6, 08/270. *Copper.*

E.F.P. 98/149, 99/161; M.P., p. 69, 265; R. 98/22. *Telluride of Gold and Bismuth.*

Murrumbidgee River Flat Bores. E.F.P. 99/168; R. 99/11, 01/91. *Gold.*

Bark Hut or Bulga, parish of Tarrabandra, county of Wynyard, 6 miles south-east of Gundagai. R. 03/74, 07/14, 08/12. *Gold.*

Bongongalong Range, boundary between counties of Clarendon and Wynyard, north of Gundagai. R. 80/133, 83/80, 04/16, 06/12, 07/14, 11/12, 14/86. *Gold.*

Minjary Range, parish of Calafat, county of Wynyard, midway between Gundagai and Adelong. J.E.C. 00/184; M.R. No. 6, 08/382, 388, 389, 395; R. 13/13. *Copper, Silver, Gold and Limestone.*

J.E.C. 00/185. *Barytes.*

Digitized by Google

Tarrabandra, parish of Tarrabandra, county of Wynyard, 4 miles south to 8 miles south-south-east of Gundagai. R. 02/19, 04/16, 06/12, 07/14, 16/12. *Gold.*

Wagragobilly, 7 miles from Gundagai. R. 01/23, 04/16, 06/13. *Gold, Silver* (trace.)

Snowball, &c., parishes of Willie Ploma and South Gundagai, county of Wynyard, south of Gundagai; Mount Lightning, Kangaroo Mount, &c., parishes of Darbalara and Wagara, county of Buccleuch, east and south-east of Gundagai; Reno and Jones' Creek, parish of North Gundagai, county of Clarendon. J.E.C. 99/170; M.R. No. 6, 08/276, &c.; R. 76/125, 77/159, 06/47, 07/53, 08/48, 11/53, 17/42. *Copper.*

Mount Lightning, Honeysuckle, and Mooney Mooney Ranges, Kangaroo Mountain, &c., Serpentine belt, north-east, east, and south-east of Gundagai, counties of Harden and Buccleuch. E.F.P. M.R. 285; J.F.C. 95/125, 97/149; M.R. No. 1, 1898; R. 00/65, 05/53. Assay, 02/131, 12/195. *Chromite.*

Jones' Creek, North Gundagai. C.S.W. 79/217; E.F.P. M.R., p. 423; R. 78/118, 79/128, 84/86, 85/109, 07/66, 09/59, 15/62, 17/55. Assay, 16/223. *Asbestos.*

5 miles north-east of Tumblong, Adelong Crossing, parish of Willie Ploma, county of Wynyard. Assay, 07/181, 16/220. *Manganese.*

South Gundagai. R. 82/74. *Slate.*

J.E.C. 97/170; M.R. No. 2, 1898; E.F.P. M.R., p. 301 *Wolfram.*

M.P 82/95, 100, 108. *Iron, Antimony, Lead.*

Murrumbidgee River, parish of Mundarlo; Tumut River, parish of Tarrabandra; Mount Minjary, Mount Horeb, parish of Calafat, county of Wynyard, 11 miles west-south-west, 8 miles south-east, and 10 miles south of Gundagai; M.P. 82/173; M.R. No. 25, 19/350; R. 89/87, 15/57. Assay, 75/141. *Limestone.*

Parish of Kimo, county of Clarendon. M.R. No. 25, 19/206. *Limestone.*

GUNDAMULDA CREEK. Parish of Drummond, county of Murchison, 22 miles south-east of Bingara. M.P. 82/114. *Chromite.*

GUNDAROO. [*See* Bywong.] Parish of Toual, county of Murray, between Gundaroo and Morumbateman. R. 16/58. *Bismuth.*

GUNDERBOOKA MOUNTAIN. Parishes of Gonella and Penilui, county of Yanda, 40 miles south-south-west of Bourke. E.C.A. 11/179; R. 98/54, 01/90, 09/108, 10/97, 11/90, 13/105, 14/101, 17/91. *Gold.*

GUNDIBINDYAL CREEK. [*See* Temora.]

GUNDLE. Rollands Plains, parish of Belangry, county of Macquarie, 24 miles south-west of Kempsey. J.E.C. M.R. No. 14, 11/286; R. 91/127, 96/48, 00/59, 02/53, 03/51, 04/50, 05/48, 06/52, 07/58, 80, 08/53. *Tin.*

GUNGOANDRA. [*See* Bredbo.]

GUNGARLINE RIVER. [*See* Jindabyne.]

GUNNEDAH. [*See* Coal Index.]

Zarrari, near Gunnedah. R. 05/18, 06/49. *Gold, Silver, Copper* (reported.)

GUNNERS DAM. [*See* Wellington.]

Digitized by Google

GUNNING. Jerrawa Railway Station, west of Gunning, county of King. R. 75/90, 88/87. *Silver, Copper.*

Parish of Jerrawa, Limekiln, parish of Mundoonen, 3 to 8 miles south and south-east of Jerrawa. M.R. No. 25, 19/260. *Limestone.*

Jerrawa Creek, Mundoonen Range, north and south of Dalton, north-west to south-west of Gunning. R. 75/89, 90, 83/76, 88/87, 11/24. *Gold.*

GUNNINGBLAND. [*See* Parkes.] Parish of Milpose, county of Ashburnham, 7 miles north of Gunningbland. J.E.C. M.R. No. 6, 98/275, 280. *Copper.*

Parish of Nelungalong. M.R. No. 25, 19/172. *Limestone.*

GUNTAWANG. Rec. VI, pt. 4, 00/245. [*See* Gulgong.]

GURRUNDA. [*See* Breadalbane.]

GUY FAWKES and Hernani. [*See* The Valley.]

Biscuit Creek, parish of Rigney, county of Clarke, 38 miles on road Armidale to Grafton. J.E.C. M.R. No. 6, 08/309; R. 07/55, 08/50. *Copper.*

R. 98/73, 03/140, 11/57; A. 03/140, 07/183. *Tin.*

R. 00/51. *Silver.*

Parishes of Allingham and Marengo. R. 17/39. *Silver.*

GUYONG. [*See* Blayney.]

GUYRA. County of Sandon, 19 miles north of Armidale. J.E.C. M.R. No. 6. 99/121. *Copper.*

J.E.C. 97/171, M.R. No. 2, 1898; E.F.P. M.R. p. 301. *Sheelite.*

8 miles east of Guyra. Assay 06/181, 07/183; Dredge, 04/30. *Tin.*

15 miles east of Guyra. Assay 06/178. *Gold, Bismuth.*

GUYDIR RIVER. [*See* Bingara, Tingha, Inverell, &c.]

GYPSUM PALACE. [*See* Banoona.]

HALL. Parish of Ginninderra, county of Murray, 24 miles south-west of Yass. J.E.C. M.R. No. 6, 08/382. *Copper, Gold.*

HALLIDAY'S POINT. Parish of Beryan, county of Gloucester, 10 miles north of Tuncurry. J.E.C., 13/181. *Supposed Oil.*

HALL'S CREEK. [*See* Bendemeer, Bingara, Manilla, and Niangala.]

HALL'S GRAMPIANS AND SUGARLOAF. [*See* Vegetable Creek.]

HALL'S PEAK. [*See* Chandler River.]

HAMILTON RIVER. Parish of Hamilton, county of Gough. *Tin.*

HAMPTON. County of Westmoreland, south of Mount Victoria. J.E.C. M.R. No. 6, 08/18. *Copper.*

HANGING ROCK. [*See* Nundle.]

HARDEN and Murrumburrah and vicinity, county of Harden. R. 75/43, 83/66, 84/69, 95/20, 97/34, 02/19, 03/16, 04/16, 05/18, 06/14, 85, 07/16, 08/14, 09/13, 10/14, 11/14, 12/13, 13/14, 14/15, 86. *Gold.*

Grassy Creek, R. 95/21. Phils Creek, R. 94/24. *Gold.*

Kemp Hill, &c., Cunningham's Creek, Marshall MacMahon's, and Cunningar Mines, parish of Cumbamurra, 12 miles south-east of Harden. C.S.W. 76/156; Rec. VI, pt. 4, 00/234; R. 85/61, 87/65, 95/20, 96/70, 05/18, 10/86; Dredge 01/36. *Gold, Silver.*

South of Cumbamurra, R. 75/80. *Gold.*

Blind Creek, Cunningar and Harden Mines, parishes of Cunningar, Currawong, and Murrimboola. J.E.C. 01/162; R. 87/65, 10/86. *Gold.*

Digitized by Google

Demondrille, between Young and Harden. C.S.W. 76/156; R. 17/12; Dredge 01/162. *Gold, Sheelite.*

Garangula, parish of Cunningham, 11 miles south of Harden. E.F.P. 94/109, 95/118, 124; R. 94/24, 95/20. *Gold.*

Near Harden. J.E.C. 97/150; M.R. No. 1, 1898; R. 75/43. *Chromite.*

R. 18/48. *Iron Oxide.*

R. 15/64, 18/64. *Kaolin.*

Murrumburrah. R. 17/56, 18/64. *Steatite.*

Galong, parish of Nurung, 11 miles north-east of Murrumburrah. M.R. No. 25, 19/253. *Limestone.*

HARGRAVES. Meroo, Louisa and Louisa Ponds Creeks, Tucker's Hill, parish of Hargraves, county of Wellington, 14 miles south-south-west of Mudgee. [*See* Windeyer.] J.A.W. Rec. V, pt. 4, 1898; VI, pt. 2, 1899; E.F.P. 00/176, 06/165; M.R. p. 29, 33; Rec. VI, pt. 4, 00/224, 234, 242; R. 75/72, 73, 74, 93/20, 94/77, 95/18, 99/25, 00/16, 02/77, 03/18, 04/19, 90, 05/14, 06/18, 07/20, 08/18, 11/19, 12/17, 13/19, 88, 14/20, 87, 15/18, 29, 16/17. *Gold.*

Maitland Bar, Meroo Creek, parish of Grattai, 3 miles north-west of Hargraves. J.E.C. Rec. Vol. I, 89/37. *Gold.*

Campbell's Creek, Upper Meroo, parish of Warratra, 10 miles east of Hargraves. J.E.C. M.R. No. 16, 12/46. *Antimony, Gold.*

Merindee, Meroo Creek, parish of Merinda, north-west of Hargraves. R. 82/48, 83/60, 84/62, 04/19, 09/17, 13/19. *Gold.*

Louisa Creek. W.A. Rec. III, pt. 1, 1892. *Opal.*

M.P. 82/117. *Manganese.*

Macquarie River, between Stuart Town and Hargraves. Dredge 16/28. [*See* Cudgegong.] *Gold.*

HARGRAVES FALLS. M.P. 82/100. County of Sandon, 19 miles east of Armidale. *Antimony.*

HARTLEY. County of Cook. [*See* Coal Index.] E.F.P. M.R. p. 2; M.P. 82/22; Rec. VI, pt. 4, 00/214; R. 95/17. *Gold.*

HARTLEY VALE. R. 17/56; L.F.H. M.R. No. 26, 17/13. *Felspar.*

HARTWOOD. [*See* Nymagee.]

HARVEY RANGES. [*See* Peak Hill.]

HASTINGS RIVER. [*See* Wauchope and Jasper Peak.]

Kalobungung or Long Creek, Ellenborough River, parish of Innes, county of Macquarie, 32 miles south-west of Port Macquarie. M.R. No. 25, 19/271. [*See* Comboyne.] *Limestone.*

King Creek, near Wauchope. *A.* 04/153. *Limestone.*

Huntington, near Wauchope, parish of Koree, 16 miles west-south-west of Port Macquarie. J.E.C. M.R. No. 6, 03/263, 268; R. 05/46, 07/23. *Copper, Gold.*

Kindee, parish of Kindee, 30 miles west of Port Macquarie. J.E.C. M.R. No. 6, 03/263. *Copper, Silver, Lead.*

Frasers' Creek, parish of Pappinbarra, 16 miles west of Port Macquarie. *Silver.*

Bril Bril, parish of Cogo, 20 miles west of Port Macquarie. Assay 03/140, 06/181. *Tin.*

Morton's Creek. Assay 06/179. *Manganese.*

HAVILAH. [*See* Mudgee.]

HAWKIN'S HILL. [*See* Hill End.]

Digitized by Google

HAWKESBURY RIVER. R. 09/60; Assay 06/181. *Pigments, Red Ochre.*

HAWKSVIEW. [*See* Albury.]

HAYDEN'S BOG. [*See* Delegate.]

HAYSTACK MOUNTAIN. [*See* Vegetable Creek.]

HAZELGROVE. [*See* Oberon.]

HEATHCOTE. [*See* Coal Index.]

HEFFERNAN'S CREEK (or Hefferons). [*See* Breadalbane.]

HELL'S HOLE, Mudgee Railway Line. J.E.C. M.R. No. 16, 12/31. *Antimony.*

HERBERT CREEK. [*See* Armidale.]

HERDING YARD CREEK. [*See* Wilson's Downfall.]

HERDING YARD GULLY. [*See* Tingha.]

HERMIDALE. Budgery and Budgerigar, parish of Hermitage, county of Canbelego. J.E.C. M.R. No. 6, 08/194, 247, 261; E.C.A. M.R. No. 18, 1913; R. 91/149, 07/51, 90, 08/45, 95, 09/108, 10/97, 11/51, 89, 90, 12/94, 13/12, 47, 51, 103, 14/52, 84, 15/48, 97, 17/91. *Copper, Iron with Gold and Silver.*

J.B.J. 95/175; R. 95/84, 06/45. *Gold.*

Miandetta Station. R. 05/44. *Copper.*

HERMITAGE PLAINS. [*See* Canbelego.]

HERNANI. [*See* Guy Fawkes]

HEXHAM. [*See* Coal Index.]

From Hexham north-easterly, east of Hunter River, to Swan Bay. L.F.H. 17/166. *Iron Ore.*

HIAWATHA. [*See* Wyalong.]

HIGHLAND HOME. [*See* Vegetable Creek.]

HILLAS or Yaran Creek, parishes of Yaran and Mundarlo, county of Wynyard. R. 79/126, 83/81. *Gold.*

HILL END. Parish of Tambaroora, county of Wellington. C.S.W. 79/213; E.F.P. map 1879, 98/150, 00/177; M.R. p. 27, 30, 31; Rec. VI, pt. 2, 99/81; J.A.W. 98/174; Rec. VI, pt. 4, 00/230, 234; L.F.H. M.R. No. 27, 1918; R. 75/24, 29, 66, 76/38, 77/59, 80/88, 95/19, 96/11, 02/27, 04/25, 05/23, 06/17, 07/19, 08/17, 09/16, 10/17, 11/18, 12/17, 13/18, 87, 14/19, 87, 15/17, 86, 16/16, 17/14, 18/14, 78; Turon River Dredge 03/24, 09/26, 10/27, 11/29. *Gold.*

Hawkins' Hill. C.S.W. 79/213; Salvation Hill. R. 00/16, 05/14. *Gold.*

Tambaroora, parishes of Carrol, Cunningham and Tambaroora. Parliamentary Paper, G.F. of N.S.W., 1873–4; Rec. VI, pt. 4, 00/224, 230; R. 75/23, 11/18, 14/19, 15/17, 17/14; Dredge, 13/29. *Gold.*

Bald Hill, Sally's Flat, Mount Andrews, Monkey Hill, parish of Cunningham, 10 miles east of Hill End. J.A.W. 98/175; Mines and Minl. Stat. 75/115; C.S.W. 79/214; M.P. 82/122; E.C.A. 03/133; Rec. VI, pt. 4, 00/298; R. 95/19, 96/11, 07/19, 59, 10/18. *Gold, Diamonds.*

Gold reefs occur from Dirt Holes on the north, parishes of Carroll and Cummings, county of Wellington, to Root Hog, near Macquarie River, parish of Coleridge, county of Bathurst; Chambers' Creek, parish of Coleridge. R. 75/23, 38. *Gold.*

Digitized by Google

Pulley's Hill, parish of Ulmarrah, county of Wellington, 8 miles west of Hill End, near Macquarie River. R. 75/28, 78/65. *Gold.*

Tatuali Mt., parish of Tatuali, 8 miles north-north-west of Hill End. M.R. No. 25, 19/340. *Limestone.*

Quartz Ridge, 15 miles from Hill End. [*See* Sofala.] R. 90/135. *Gold.*

District. M.R. No. 16, 12/31. *Antimony.*

HILLGROVE. Baker's Creek, &c.

Parishes of Metz and Cooney, county of Sandon, 15 miles east of Armidale. C.S.W. 82/26, 83/153; E.F.P. M.R. p. 38, 246; E.C.A. M.R. No. 8, 1900; Rec. VIII, pt. 2, 1906; J.B.J. 04/72, 05/61; Rec. VI, pt. 4, 00/232; J.E.C. M.R. No. 16, 1912; R. 89/100, 130, 90/107, 95/27, 64, 98/47, 99/38, 00/28, 01/27, 85, 02/23, 75, 03/20, 73, 04/21, 05/16, 52, 06/19, 56, 96, 07/21, 62, 176, 08/19, 09/18, 10/19, 11/20, 12/18, 13/20, 63, 14/21, 63, 15/19, 58, 16/18, 57, 93, 17/16, 51, 18/15, 50. *Gold, Antimony.*

J.E.C. 97/171; M.R. No. 15, 1912; E.F.P. M.R. p. 301; E.C.A. M.R. No. 8, 1900, 04/142, 05/150; R. 98/75, 99/76, 00/67, 04/152, 06/59, 07/64, 08/57, 59, 09/58, 10/57, 11/64, 12/60, 13/65, 14/65, 15/61, 16/60, 17/53, 86, 18/57, 84. *Tungsten, Sheelite.*

Gara, or Guyra, or Gyra Falls, 6 miles south-west of Hillgrove. J.E.C. M.R. No. 16, 12/31; R. 80/139. *Gold, Antimony.*

J.E.C. 97/169; E.F.P. M.R. p. 297. *Tungsten, Sheelite.*

J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 265. *Bismuth.*

Metz. R. 14/21; Assay, 07/182. *Nickel.*

Woolomombi River. Parish of Woolomombi, county of Sandon, "Old Find," 11 miles north "New Find," 10½ miles north-north-east of Armidale. J.E.C. 98/159; E.F.P. M.R. p. 123; R. 91/116, 95/56, 98/68, 02/131 [*See* Chandler River.] *Gold, Silver, Antimony.*

Rockvale, parish of Clevedon, county of Sandon, 13 miles north of Hillgrove. J.E.C. M.R. No. 6, 99/154. *Copper.*

R. 98/47, 68, 99/64, 00/51, 16/44, 18/36. Ruby Mine. *Gold, Silver.*

Baker's Lode, Woolomombi River, parish of Chandler, county of Clarke, 13 miles north-east of Hillgrove. R. 98/47, 68. *Silver.*

Oakton, parish of Snowy, county of Clarke, 23 miles east of Hillgrove. J.E.C. M.R. No. 14, 11/295. *Tin.*

Conningdale, 03/44, 04/42. *Silver.*

HILLMAN'S TANK. [*See* Bobadah.]

HILLSIDE. [*See* Holbrook and Tuena.]

HILLSTON. [*See* Bootheragandra.] Parish of Molesworth, county of Nicholson, 15 miles south-south-east of Hillston. M.R. No. 25, 19/297. *Travertine.*

HILL TOP. [*See* Sofala and Coal Index.]

HINCHMAN'S CREEK. [*See* Jenolan.]

HOBBY'S YARDS. [*See* Newbridge.]

HOGUE'S CREEK. [*See* Glen Innes.]

Digitized by Google

HOLBROOK (late Germanton). [*See* Copabella, Mt. Pleasant, &c.] Parish of Germanton, county of Goulburn. J.E.C. M.R. No. 14, 11/261, 263; L.F.H. 12/190; R. 95/22, 12/54; Dredge, 07/30, 08/27, 12/26. *Tin.*

Spring, Mt. Pleasant, and Lock Up Creeks, parish of Jergyle, 8 miles south-east of Holbrook. J.E.C. M.R. No. 14, 11/262; R. 95/60, 12,/54. *Tin.*

Parish of Narra Narra Wa, 12 miles south-south-east of Holbrook, Buckeen and Cockatoo Creeks, Talmalmo, parish of Talmalmo, 17 miles south east of Holbrook. Tiverton, near Holbrook, Kildrumorie. J.E.C. M.R. No. 14, 11/260, 261; R. 06/52, 07/58, 08/53, 14/59, 15/54, 16/54. *Tin.*

Mountain Creek, parish of Woomargama, 6 miles south-south-west of Holbrook. Toonallook, parish of Mullanjandra, 15 miles south-south-west of Holbrook. J.E.C. M.R. No. 14, 11/258, 262. *Tin.*

Dean's or Four Mile Creek, parish of Murray, 14 miles north-east of Holbrook. Hillside, parish of Little Billabung, 20 miles north-east of Holbrook. Yallock, near Holbrook. R. 95/22, 00/25, 06/14, 09/14, 10/14, 11/15, 14/15, 15/14. *Gold.*

Kinross Station, 8 miles north of Holbrook. R. 09/48. *Copper.*

Jingellic Road, 4 miles south-east of Holbrook. E.C.A. M.R. No. 24, 16/193. *Molybdenite.*

Parish of Back Creek, 12 miles north of Holbrook. J.E.C. M.R. No. 15, 12/57. *Tungsten.*

Parish of Germanton. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 264; Assay, 06/178. *Bismuth.*

HOLMWOOD. [*See* Cowra.]

HOLT SUTHERLAND. [*See* Coal Index.]

HOME CREEK. [*See* Basin Creek.]

HOME RULE. [*See* Gulgong.]

HONEYBUGLE. [*See* Tottenham.]

HONEY'S CREEK. [*See* Uralla.]

HONEYSUCKLE CREEK. [*See* Uralla.]

HONEYSUCKLE RANGE. [*See* Gundagai and Rydal.]

HOOKANVILLE CREEK. Rec. VI, pt. 4, 06/199. *Gold.*

HOPE, MT. Parishes of Mt. Hope and Gilgunnia, county of Blaxland. L.Y. 80/260; J.B.J. Rec. IV, pt. 1, 1894; J.E.C. M.R. No. 6, 08/18, 226, 250; M.P. 82/26; R. 83/126, 84/110, 121, 93/64, 95/61, 00/103, 01/90, 02/48, 80, 03/46, 04/13, 06/45, 94, 07/51, 08/46, 95, 13/51, 104, 14/52, 100, 15/48, 16/47, 17/41, 89, 18/41, 92. *Copper.*

Mount Allen, Double Peak, or Mt. Dromedary, parish of Mt. Allen, 8 to 12 miles north of Mt. Hope. Coan Peak, parish of Coan, west of Mt. Allen. J.B.J. 93/118; E.F.P. M.R. p. 51, 66; J.E.C. M.R. No. 6, 08/253; R. 90/180, 99/70, 04/45. *Copper, Iron Flux with Silver.*

Ironstone Hill, near Mt. Dromedary. R. 90/129, 131; 91/142, 92/20, 93/64, 96/37, 99/48, 07/13. *Gold.*

Mt. Solitary, parish of Mt. Solitary, 3 miles east and south-east of Mt. Hope. E.F.P. M.R. p. 266; R. 04/13, 53; 05/13, 52; Assay, 04/151. *Gold, Silver, Bismuth.*

Coan Downs, 10 miles north of Mt. Hope. R. 00/34. *Gold.*

Illewong, parish of Illewong, 18 miles east of Mt. Hope. R. 95/30. *Gold.*

Parish of Killeen, 22 miles north-north-west of Mt. Hope. J.E.C. M.R. No. 6, 08/254. *Copper.*

Digitized by Google

HOREB, MT. [*See* Gundagai.]
HORNSBY RANGE. [*See* Broken Hill.]
HORSE CREEK. [*See* Jingellic.]
HORSE SHOE BEND.
Clarence River. [*See* Lionsville.]
Cudgegong River. 5 miles below junction with Reedy Creek. [*See* Gulgong.] *Gold.*
Shoalhaven River. Parish of Marlowe, county of St. Vincent, 16 miles north of Braidwood. *Gold.*
Parish of Inverary, county of Argyle, 14 miles north-north-west of Nerrige. *Gold, Copper.*
HORTON RIVER. [*See* Bingara.]
HORTON'S CREEK. Grafton to Armidale-road, county of Fitzroy, 12 miles from Nymboi Punt. R. 93/24. *Gold.*
HOWE RANGE. [*See* Nadgee.]
HOWELL. Borah Creek, parish of Mayo, county of Hardinge, 13 miles south-south-east of Inverell.
G.A.S. 91/262; E.F.P. M.R. p. 120, 132; J.E.C. M.R. No. 6, 08/320; M.P. 82/32; R. 91/114, 98/68, 99/65, 00/61, 94, 01/50, 02/45, 51, 75, 03/43, 05/41, 06/42, 49, 07/46, 55, 08/41, 10/44, 49, 11/48, 55, 12/44, 51, 13/48, 14/55, 15/45, 16/44, 17/39, 18/36.; Dredge, 06/27. *Copper, Silver, Lead, Tin.*
C.S.W. 86/42; J.E.C. M.R. No. 14, 11/303, 339; M.P. 82/122; R. 03/52, 05/47. *Tin, Diamonds.*
R. 08/60, 10/58. *Arsenic.*
HUMULA CREEK. [*See* Tumbarumba.]
HUNTER RIVER DISTRICT. Rec. VI, pt. 4, 00/230. [*See* Coal Index.]
HUNTINGTON. [*See* Hastings River.]
HYANDRA CREEK. [*See* Dubbo and Yeoval.]
HYDRA. [*See* Nimmitabel.]

ICELY. [*See* Lewis Ponds.]
ILFORD. Near Railway Station, parish of Clandulla, county of Roxburg. T.W.E.D. 91/213; J.B.J. Mem. G. 2, 01/143. *Iron.*
Parishes of Warrangunia and Crudine, 6 miles west of Ilford. L.J.J. 17/169; M.R. No. 25, 19/319. *Limestone, Wolfram.*
ILLABO. [*See* Junee.]
ILLALONG. County of Harden, 12 miles north-west of Yass. *Gold.*
ILLEWONG. [*See* Cobar and Mount Hope.]
ILLUNIE MOUNTAIN. [*See* Cowra.]
INDI RIVER. State Boundary, parish of Twynam, county of Selwyn. Alternate belts of limestone from Marble and Pilot Creeks northerly to Big Bogong, parish of Jagungal. M.R. No. 25, 19/326. *Limestone.*
INVERELL. [*See* Copeton and Tingha.] Auburn Valley Creek, Gwydir River. Malacca, Collas Hill, &c., parishes of Aconite, Clare, Mayo, and Auburn Vale, 7 miles south-west of Inverell.
W.A. 87/155; R. 08/52, 09/52, 11/57, 12/52, 13/56, 14/57, 18/44. *Tin, Gems, Diamonds.*
Staggy Creek, Red Hill, parish of Gum Flat, county of Murchison, 14 miles south-west of Inverell.
W.A. 87/156. *Gems, Diamonds, Tin and Gold.*
Inverell vicinity.

Digitized by Google

E.F.P. M.R. p. 410; Rec. VI, pt. 4, 00/299; R. 03/32.
Diamonds, Sapphires.

J.E.C. M.R. No. 14, 11/172; Rec. VI, pt. 4, 00/320.
R. 01/57, 13/56, 14/56, 15/52. ***Tin.***

Middle Creek. From Stannifer, north-west to Inverell, county of Gough. [*See* Tingha.]

C.S.W. Mines and Min. Stat. 75/85; E.F.P. M.R. p. 134; M.P. 82/103; Dredge, 06/27, 15/29, 16/28, 17/23, 18/44. ***Molybdenite, Tin.***

The Brothers, Macintyre River, county of Gough, 15 miles east-south-east of Inverell.
G.A.S. 91/262; R. 91/114. ***Silver.***

Rocky Creek and Swan Brook, parish of Swanvale, county of Gough, 13 miles east-north-east of Inverell.
G.A.S. 91/262; Assay, 97/190. ***Silver.***

Parish of Nullamana, county of Arrawatta, 16 miles north of Inverell.
J.E.C. M.R. No. 16, 12/41. ***Antimony.***

IODIDE. [*See* Condobolin.]

IRONBARKS. [*See* Barraba and Stuart Town.]

IRONBARK REEFS. [*See* Forbes.]

IRONCLAD RANGE. [*See* Cargo.]

IRON POT CREEK. Rec. VI, pt. 4, 00/197. ***Gold.***

IRONSTONE HILL. [*See* Mount Hope.]

IRONSTONE MOUNTAIN. [*See* Port Stephens.]

ISABELLA RIVER. [*See* Burraga.]

ISIS RIVER. [*See* Murrurundi.]

IVANHOE. County Mossgiel. ***Gypsum.***

JACKALASS. [*See* Gundagai.]

JACKASS CREEK. [*See* Dalmorton.]

JACK'S CREEK. [*See* Canowindra.]

JACK'S LOOKOUT. [*See* Fifield.]

JACOB'S SWAMP, or Moggs.
Parish of Worra, county of Gresham, 30 miles east of Glen Innes.
E.C.A. 05/150; J.E.C. M.R. No. 14, 11/336.
R. 07/57, 08/19, 14/23, 18/16; Dredge, 09/26. ***Tin, Gold.***

JACOMBIE. [*See* Gordonbrook.]

JAMBEROO MOUNTAIN. [*See* Kiama.]

JANGA. [*See* Bega.]

JAQUA, or Jacqua. [*See* Bungonia.]

JARVISVILLE. [*See* Picton.]

JASPER'S GULLY. [*See* Bungonia.]

JASPER PEAK. Forbes and Hastings Rivers, parish of Jasper, county of Macquarie, north of Yarras, 40 miles west of Port Macquarie.
J.E.C. MR. No. 6, 08/265; E.C.A. M.R. No. 24, 16/170.
R. 00/56, 03/48, 04/47, 05/46, 77, 06/48, 07/55, 18/80.
Molybdenite, Copper, Iron.

Cowan, 10 miles from Yarras. R. 80/154. ***Gold.***

JAUNTER. [*See* Tuglow.]

JAW BONE. [*See* Bodangora.]

JEFF'S CREEK. [*See* Cooma.]

JEIR CREEK. [*See* Yass.]

JELLORE MOUNTAIN. 5 to 7 miles north-north-west of Mittagong.

Digitized by Google

JELLEINDORE. [*See* Oberon.]

JEMBAICUMBENE. [*See* Major's Creek.]

JENNY LIND. [*See* Drake.]

JENOLAN CAVES. Parish of Jenolan, county of Westmoreland, 36 miles south of Mount Victoria. *Sydney Morning Herald*, 5/6/63, &c.; J. E. Ritchie, *Scientific American*, 1884, No. 15; S. Cook, "The Jenolan Caves: An Excursion into Australian Wonderland, 1889"; C.S.W., Railway Guide, 1886; W.S.L. 88/202, 93/140, 94/156; Rec. IV, pt. 2, 94/66; Foster's Guide Book, 1890; R.E. 91/269; Rec. III, pt. 1, 92/57; A. Tissandier, Bull. Soc. Spéléologie, 1895, 1 No. 2, pp. 50, 56; Cyril Haviland, Poetical Description, Turner and Henderson, Sydney; T.W.E.D., Proc. Roy. Soc. of N.S.W., 1896, p. 33; O.T. 97/206, 00/199, 01/68, 03/136, 11/194, 18/166; Guide Book, 3rd edition; R.E. and O.T., Rec. VII, pt. 4, 04/325; F. Lambert, Journ. Manchester Geographical Soc., vol. XXI, Nos. 9 to 12, 1905; C. A. Sussmilch, Aust. Assoc. Adv. of Science, 1911, p. 20; C. A. Sussmilch and W. G. Stone, Proc. Roy. Soc. N.S.W., 1915, vol. XLIX, p. 332; M.R. No. 25, 19/347. *Limestone.*

Parish of Bindo, 7 miles north-north-west of Jenolan; Bundook, Limestone, and Murruin Creeks, parishes of Murruin and Oldbuck, 22 to 24 miles south-south-east of Jenolan. M.R. No. 25, 19/344, 348. *Limestone.*

Tuglow Caves, parish of Drogheda, 10 miles south-west of Jenolan. O.T. 97/205. [*See* Tuglow.] M.R. No. 25, 19/345. *Limestone.*

Colong Caves, Lanigan's and Church Creeks, parishes of Colong and Tartarics, 6 miles west-north-west to west-south-west of Yerranderie, 10 to 20 miles south-east of Jenolan. O.T. 99/211; J.E.C. and L.J.J. M.R. No. 25, 19/345. *Limestone.*

Bulls' and Hinchman's Creeks, parish of Jenolan. J.E.C. M.R. No. 6, 08/116; R. 98/28. *Copper.*

JERGYLE, MOUNT. [*See* Basin Creek.]

JERRABOMBERRA CREEK. [*See* Queanbeyan.]

JERRABUT GULLY. [*See* Krawarree.]

JERRALONG. } [*See* Bungonia.]
JERRARA. }

JERRAWA. [*See* Gunning and Yass.]

JERRAWANGALA. Parish of Cudmirrah, county of St. Vincent, 12 miles north of Milton. R. 11/58. *Tin.*

JERRICKNORRA. [*See* Corang River.]

JERUSALEM CREEK. [*See* Woodburn.]

JERVIS BAY. Parish of Bherwerre, county of St. Vincent. J.B.J. Mem. G2, 01/127; Assay 06/179. *Iron.*

JEW'S, or Wallaby Creek. [*See* Sofala.]

JEW'S CREEK. [*See* Molong and Portland.]

JILLIMATONG. [*See* Cooma.]

JINDABYNE. Parish of Jinderboine, and parishes of Abington and Mowamba, 6 miles south to south-west of Jindabyne, county of Wallace. J.B.J. 96/133; J.E.C. M.R. No. 6, 08/382, 394; M.R. No. 14, 11/284; M.P. 82/102; R. 05/23, 14/59, 15/14. A. 06/181. *Gold, Copper, Tin.*

Crackenback Range, parishes of Thredbo and Bloomfield, 12 to 18 miles south-west of Jindabyne. J.B.J. 96/133; Rec. VI, pt. 4, 60/197, 198. *Gold.*

Digitized by Google

JINDALEE. Cootamundra Division. R. 17/55, 56. *Chromite, Kaolin.*

JINDERA. [*See* Albury.]

JINGELLIC. Parishes of Jingellec, county of Goulburn, and Jingellec East, county of Selwyn, 20 miles south-west of Tumbarumba. E.F.P. 81/143; M.R. p. 145, 296, 301; J.E.C. 97/171; M.R. No. 15, 12/59, 90; M.R. No. 14, 11/264, 269; R. 76/67, 77/99. Assay, 06/181. *Tin, Wolfram.*

No Place, parish of Munderoo, county of Selwyn, 9 miles north-east of Jingellic. W.A. 90/286. *Gold.*

Carboona, north of Jingellic. R. 07/47, 16/43. *Silver Lead.*

R. 16/62, 17/55, 18/57, 62. *Fluorspar.*

Ournie, or Ouranee, parishes of Ouranee and Glenken, county of Selwyn, east of Jingellic, 17 miles south-west of Tumbarumba. R. 76/101, 84/87, 01/26, 04/26, 05/79. *Gold, Silver.*

JINGERA. [*See* Pambula.]

JINGLEMONEY. [*See* Braidwood.]

JOADJA. [*See* Coal Index.]

JOE'S YARDS. [See Clarence Town.]

JONES CREEK. [*See* Gundagai.]

JOUNAMA CREEK. [*See* Talbingo.]

JUGIONG. Murrumbidgee River, parish of Birrema, county of Harden, south-east of Jugiong. J.E.C. M.R. No. 6, 08/365. *Copper, Iron* (poor).

Parish of Nanangroe, Oak Creek, parish of Bangongo, county of Buccleuch, 8 to 10 miles south-east of Jugiong, M.R. No. 25, 19/197, 198. *Limestone.*

JUMBLE PLAINS. [*See* Condobolin.]

JUNCTION POINT (Gillendich). [*See* Tuena.]

JUNCTION REEFS. [*See* Mandurama.]

JUNEE. County of Clarendon. Eurongilly, 11 to 15 miles south-east of Junee; Sebastopol 20 miles north-west, Wantiool 7 miles east, Wantabadgery 16 miles south-east (see.), Houlaghan's Creek, 9 miles north-north-east, Emerald and Pike's Reefs, 12 to 14 miles north-east of Junee. J.E.C. 94/118; R. 89/90, 92/19, 95/23, 98/39, 99/31, 00/25, 01/25, 14/15, 18/11. *Gold.*

Parish of Eurongilly. J.E.C. 94/126. *Magnesite.*

Parishes of Houlaghan and Eurongilly. J.E.C. 97/149; M.R. No. 1, 1898. *Chromite.*

Parish of Warre Warral, 12 miles north of Junee. J.E.C. M.R. No. 6, 08/283; R. 97/37, 16/13. *Copper, Gold, Silver.*

Parish of Mitta Mitta, 24 miles east of Junee. R. 11/66. *Baryte.*

Erin Vale Station. Assay, 06/179. *Cobalt.*

Parish of Boree, 10 miles east-north-east of Junee. Near Illabo. M.R. No. 25, 19/205. *Limestone.*

KADUMBLE RANGE. [*See* Catombal, under Wellington.]

KALLARA STATION. County of Killara, 80 miles north-east of Wilcannia. R. 89/122. *Silver.*

KALOE. [*See* Cangai.]

KANANGRA WALLS. Thurat Plateau. [*See* Coal Index.]

KANDIE PEAK, 26 miles from White Cliffs, on Mount Browne Road. *Gold.*

Digitized by Google

KANDOS. R. 17/50, 18/49; M.R. No. 25, 18/9, &c. [*See* Carwell Creek.] *Limestone.*

KANGALOOLA. 3 miles south of Tilema (Sec.).

KANGALOON. [*See* Mittagong.]

KANGARI. [*See* Coramba.]

KANGAROO CREEK. [*See* Boorook and Moonan Flat.]

KANGAROO MOUNTAIN. [*See* Gundagai.]

KANGAROO RIVER. Junction of Kangaroo River and Shoalhaven River. *Silver, Copper.*

KANGAROO VALLEY. [*See* Coal Index.]

KANGIARA. [*See* Binalong.]

KANIMBLA. [*See* Lowther.]

KANOWIE PEAK. Mount Browne road, 80 miles from Wilcannia. R. 89/124. *Gold.*

KANTAPPA. [*See* Euriowie.]

KARANGI. [*See* Coramba.]

KARUAH RIVER. [*See* Port Stephens.]

KATELLA. [*See* Stuart Town.]

KATOOMBA. [*See* Coal Index.] Pearce's Creek, Cox River, parish of Cooba, county of Cook, 14 miles south-south-east of Katoomba. M.R. No. 25, 19/206. *Limestone.*

KAYUGA. [*See* Kyuga, under Muswellbrook.]

KEIRA, MOUNT. [*See* Coal Index.] J.B.J. Mem. G. 2, 01/113. *Iron* (poor).

KELOSHIEL. [*See* Bathurst.]

KELSO. R. 17/57, 18/64. *Potter's Clay.*

KEMBLA, MOUNT. [*See* Coal Index.]

KEMP HILL. [*See* Harden.]

KEMPFIELD. [*See* Trunkey.]

KEMPSEY. [*See* Macleay River.] Moonebah Reefs, parish of Kullatine, county of Dudley, 10 miles west of Kempsey. C.S.W. 89/205; R. 91/127. *Silver.*

Toroka Creek, 15 miles south-west of Kempsey. Assay 04/151. *Silver.*

Dungay Creek, west of Kempsey. Assay 06/178, 07/176. *Antimony.*

Munga Creek, parish of Burragong, 14 miles north-west of Kempsey. L.V. 80/250; J.E.C. M.R. No. 16, 12/4, 27, 28. *Antimony.*

Parish of Bullengara, county of Macquarie, 16 miles south-west of Kempsey. *Tin.*

Bellbrook. Assay 06/181. *Tin.*

Moonebah, 11½ miles north-west of Kempsey and 4 miles west. [*See* Macleay River.] R. 00/66; Assay 07/178. *Cobalt, Maganese.*

District. E.C.A. M.R. No. 24, 16/91. *Molybdenite.*

Macleay River, parish of Kullatine, county of Dudley, 8 to 10 miles west to west south-west of Kempsey. Includes Yessabah Caves. C.S.W. Papers Misc. 89/10968; M.R. No. 25, 12/11, 12, 125, 222, 223. *Marble, Limestone.*

Yessabah or Dungay Creek, parish of Wittitrin, 8 miles south-west of Kempsey, Parish of Parrabel, 13 to 21 miles west to west-north-west of Kempsey. M.R. No. 25, 19/224, 226. *Limestone.*

Willi Willi, parishes of Panton and Warbro, 22 to 26 miles west-north-west of Kempsey. M.R. No. 25, 19/224. *Limestone.*

Digitized by Google

Parish of Clarke, south-west of Willi Willi, 30 miles west of Kempsey. M.R. No. 25, 19/223. *Limestone.*

Smith's and Piper's Creeks, parishes of Lincoln, Tinebank, and Ballengarra, county of Macquarie, 10 miles south-west of Kempsey. M.R. No. 25, 19/272. *Limestone.*

KENTUCKY. [*See* Uralla.]

KENYU. [*See* Boorowa.]

KERRIGUNDAH. Parish of Narwarre, county of Yanda, 52 miles north-west of Cobar. *Gold.*

KERRIPUT. [*See* Copeland.]

KERR. Parish of Larras Lake, county of Wellington, 2½ miles south of Kerr. *Barytes.*

KERR'S CREEK. [*See* Calula.]

KIAMA. [*See* Coal Index.] Jamberoo Mountain, head of Broger's Creek, parish of Wallaya, county of Camden, 11 miles west of Kiama. E.F.P. M.R. p. 212. Iron ore deposits of N.S.W., 1910; J.B.J. Mem. G. 2, 01/54; M.P. 82/108, 112; M.P. 87/152. *Iron.*

A. 04/147. *Road Metal.*

KIANDRA. New Chum Hill, Four-mile, Nine-mile, Bullock Head Creek, Eucumbene River, &c., parish of Kiandra, county of Wallace. L.Y. 80/253; W.A. 86/165; E.C.A. 04/143; M.R. No. 10, 1901; Rec. VI, pt. 4, 00/233; R. 75/92, 76/102, 80/261, 81/71, 82/72, 85/107, 95/23, 98/95, 02/29, 04/27, 47, 05/23, 06/15, 07/17, 11/15, 12/14, 13/15, 14/16, 15/14, 16/14, 17/12, 18/11; Dredge 01/35, 02/30, 04/30, 13/30, 14/85; A. 16/225. *Gold.*

T.W.E.D. 91/229; E.F.P. M.R. p. 406. *Emerald.*

M.P. 82/118. *Wad.*

Tantangara and Nungar Creeks, parish of Tantangara, 9 miles north-east of Kiandra. R. 91/104; Dredge 12/26, 13/20. *Gold* (poor).

District. E.C.A. M.R. No. 24, 16/92. *Molybdenite.*

M.P. 82/118. *Manganese.*

KIANGA CREEK. [*See* Wagonga, under Noorooma.]

KILDARY. [*See* Ardlethan.]

KILDRUMNIE. [*See* Holbrook.]

KILLONBUTTA. [*See* Molong.]

KIMBERLEY. [*See* Boorook and Tingha.]

KIMO. [*See* Gundagai.]

KINDEE. [*See* Hastings River.]

KINGSDALE. [*See* Goulburn.]

KINGSGATE or Red Range. Yarrow Creek, Mount Morgan, parish of Kingsgate, county of Gough, 10 miles east of Glen Innes. C.S.W. 82/27, 28, 83/154; J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 259, 300, 305; J.E.C. 97/170; M.R. No. 15, 12/90; E.C.A. M.R. No. 24, 16/9, 27, 32, 92, 95, 101, 116; R. 75/111, 80/143, 81/77, 86/81, 00/64, 01/65, 02/58, 75, 130, 03/56, 04/53, 55, 05/52, 53, 06/57, 58, 07/63, 64, 08/57, 58, 09/57, 58, 10/56, 12/59, 60, 13/64, 90, 14/64, 15/59, 60, 16/58, 59, 17/51, 52, 18/51, 53, 84; Assay 79/46. *Molybdenite, Bismuth, Tungsten, &c.*

Mann and Yarrow River junction, parishes of Mann and The Brothers, 7 miles north-east of Kingsgate. E.C.A. M.R. No. 24, 16/120. *Molybdenite.*

Sheep Station Creek, parish of Kingsgate. M.P. 82/103; R. 80/143. *Tin, Gems.*

Digitized by Google

KING'S PLAINS. [*See* Blayney.]

KINROSS STATION. [*See* Holbrook.]

KIRKCONNELL. [*See* Sunny Corner.]

KIRKDALE. [*See* Yass.]

KIWARRIE. Parish of Kundibakh, county of Gloucester, 10 miles south-west of Taree. R. 02/17, 04/14, 06/21. *Gold* (poor).

KOLKILBERTOO. Parish of Kolkilbertoo, county of Cooper, 20 miles south-west of Yalgogrin. R. 13/58, 14/58. *Tin.*

KOOKARABOOKA. Parish of Seeley, county of Clarke, Junction of Oban and Mitchell or Sara Rivers, Ann River. M.P. 82/102; R. 79/147, 90/105, 95/27. *Gold.*

Bear Hill, parish of Mitchell, south-east of Kookarabooka. R. 89/102, 91/120. *Gold.*

Between Mount Mitchell and Kookarabooka, parishes of Hall and Seeley. Rec. VI, pt. 4, 00/200; R. 82/82, 83/97. *Gold.*

Oban, Backwater, Paddy's Gully, parishes of Oban and Coventry, south-west of Kookarabooka. J.E.C. M.R. No. 14, 11/336; M.P. 82/103; R. 78/120, 94/29, 95/26, 00/59, 06/51, 07/57; Dredge 03/30, 04/30. *Tin, Gold.*

Nowlands Creek, Mitchell or Sara River, parishes of Seeley and Mitchell. R. 95/27, 00/59, 11/57, 16/19; Dredge 10/27, 11/30. *Tin, Gold.*

R. 99/39. *Topaz.*

R. 18/62. *Arsenic.*

Round Mount, 28 miles from Glen Innes on Kookarabooka road. R. 93/23. *Gold.*

Ward's Mistake, Paddy's Land Ranges, parish of Blythe, 6 miles south-east of Kookarabooka; also 9 miles from Ward's Mistake near Aberfoyle and at Round Water Holes. J.E.C. M.R. No. 6, 08/311; R. 89/106, 90/39, 91/121, 06/49, 07/55, 10/49, 11/55, 13/48, 55, 17/41. *Copper, Silver.*

Oban and Mount Mitchell. J.E.C. M.R. No. 16, 12/3, 40. *Antimony.*

Ben Lomond, Lode Hill, Backwater, &c., parish of Coventry, county of Clarke, between Mount Mitchell and Oban. W.A. 89/231; J.A.W, M.R. No. 4, 1898; E.F.P. M.R. pp. 267–269; E.C.A. M.R. No. 24. 08/35, 132; Dredge 17/22, 18/19. *Tin, Bismuth, Gold, Silver and Molybdenite.*

Sara River, parish of Sara, county of Gresham. J.E.C. M.R. No. 14, 11/337; M.P. 82/103. *Tin, Gold, Silver.*

Oakwood, parish of Oakwood, county of Gresham, north of Kookarabooka. R. 75/111, 89/107. *Gold.*

KOORNINGBERRY RANGE or Koonenberry, Ponto Mine, Parish of Kooningberry, county of Mootwingee, south-west of Morden, 60 miles north-west of White Cliffs. J.E.C. M.R. No. 6, 08/100, 103; R. 98/71, 04/46, 05/44, 06/46, 07/51, 88. *Copper.*

R. 89/125. *Gold, Silver.*

Packsaddle, parish of Morden. R. 85/104. *Silver* (doubtful).

KOOROWATHA. County of Montcagle. [*See* Cowra.] R. 14/86; Assay, 02/131. *Iron, Gold, Sheelite, Tungsten, Molybdenite.*

Digitized by Google

KOOTINGAL. Betts Hill, north-east of Tamworth, parish of Moonbi, county of Inglis. E.C.A. 17/159; R. 17/53. [*See* Moonbi.] *Molybdenite, Sheelite.*

Parish of Nemingha, county of Parry. M.R. No. 25, 19/127. *Limestone.*

KOSCIUSKO. Counties of Wallace and Selwyn. J.E.C. 04/140; M.R. No. 14, 11/281; J.B.J. Rec. V, pt. 3, 97/114. *Tin.*

KOWMUNG River. [*See* Kanangra and Colong.] Parish of Merlin, county of Westmoreland. R. 08/20, 10/22. *Gold.*

Lanigan's and Church Creeks, Kowmung River, parishes of Colong and Tartarus, 6 miles north-north-west to west-south-west of Yerranderie. O.T. 99/211; M.R. No. 25, 19/345. *Limestone.*

KRAWARRE. Parish of Krawarree and Jerrabut Gully, parish of Oronmear, county of Murray, west of Shoalhaven River, 24 miles south of Braidwood. E.C.A. M.R. No. 24, 16/89. *Molybdenite.*

KULLATINE. [*See* Kempsey.]

KUNDERANG. [*See* Macleay River.]

KYBEAN. Kydra Reefs, parish of Throsby, county of Beresford, 12 miles north-east of Nimmitabel. Rec. VI, pt. 4, 00/197; R. 83/76, 04/27. *Gold.*

Kybean Caves. W.S.L. 90/311; Papers Misc. 90/22487; W.S.L. and R.E. Rec. III, pt. 1, 92/21. M.R. No. 25, 19/193. *Limestone.*

Parish of Rivers, 8 miles south-south-east of Umaralla. R. 91/107. *Silver.*

KYLOE. [*See* Adaminaby.]

KYLOO. [*See* Drake.]

KYUGA. [*See* Muswellbrook.]

LACHLAN RIVER. 50 miles west of Forbes. M.P. 82/107, 109, 122. [*See* Cowra, Forbes, Condobolin, Euabalong, &c.] *Iron, Diamonds.*

LACMALAC. [*See* Tumut.]

LAGOON CREEK. [*See* Sunny Corner.]

LAKE COWAL. [*See* Cowal.]

LAKE CUDGELLICO. [*See* Cudgellico.]

LAKE GEORGE. County of Murray. Rec. VI, pt. 4, 00/199. [*See* Bywong.] *Gold.*

LAKE GEORGE MINES. [*See* Captain's Flat.]

LAKE MACQUARIE. [*See* Macquarie.]

LAKE MOUNT. County of Farnell, near Poolamacca, west of Torrowangee. C.S.W. 87/143; J.E.C. M.R. No. 14, 11/255. *Tin.*

LAKES GRAVE CREEK. [*See* Broken Hill.]

LAMBIE MOUNT. [*See* Rydal.]

LAMBING FLAT. [*See* Young.]

LAMBS VALLEY. [*See* Glen Innes.]

LAMP CREEK. [*See* Boorowa.]

LANGS CREEK. [*See* Boorowa.]

LANIGAN'S CREEK. [*See* Colong and Mount Werong.]

LANKEY'S CREEK. [*See* Coppabella.]

LARRAS LAKE CREEK or Kerrs. [*See* Calula.]

LAURA CREEK. [*See* Bundarra.]

LAUREL HILL. [*See* Tumbarumba.]

LAUT, MOUNT. [*See* Dunedoo.]

Digitized by Google

LAWLER'S CREEK. [*See* Dungog.]

LAWSON, MOUNT, AND LAWSON'S PLAINS. [*See* Rockley and Grenfell.]

LAWSON'S CREEK. [*See* Mudgee.]

LEADVILLE. [*See* Dunedoo.]

LEANING OAK CREEK. Parish of Merinda, county of Wellington, 14 miles south-west of Mudgee. R. 75/71. *Gold.*

LECONFIELD. [*See* Coal Index.]

LETTS MOUNTAIN. [*See* Pambula.]

LEVER CREEK. [*See* Niangala.]

LEWIS PONDS. 9 miles east-north-east of Orange; Brothers Mount, parish of Freemantle, county of Bathurst, 2 miles north-east of Lewis Ponds. *Silver.*

Icely, parishes of Byng and Freemantle, 3 miles south-east of Lewis Ponds. J.E.C. M.R. No. 6, 08/143, 147, 158; R. 75/65. *Copper.*

Toms Creek, Mount Ragan, &c., parish of Worcester, from Lewis Ponds north-west. J.E.C. M.R. No. 6, 08/115, 143, 149, 150, 159; R. 13/51, 14/52, 87, 15/49, 86, 16/48, 83, 17/41, 18/39, 77. *Zinc, Copper, Sulphur.*

Rec. VI, pt. 4, 00/220, 224, 242; M.P. 82/23; E.F.P. M.R. p. 4; M.M. 18/162; R. 87/51, 111, 92/39, 15/15. *Gold, Silver.*

W.A. 87/161; M.R. No. 25, 19/185. *Limestone.*

LICKING HOLE CREEK. [*See* Belubula.]

LIDDELL. Parish of Howick, county of Durham, 5 miles south-west of Liddell. *Limestone.*

LIGHTNING MOUNT. [*See* Gundagai.]

LIGHTNING RIDGE. [*See* Wallangulla.] (17/71 full.)

LIGHTNING PADDOCK. [*See* Fifield.]

LIMEBURNERS' CREEK. [*See* Clarence Town.]

LIMEKILN GULLY. [*See* Colinton.]

LIME KILNS. [*See* Barraba.]

Fernbrook, Limestone and Limekiln Creeks, tributaries of Cheshires Creek, parishes of Jesse and Wiagdon, county of Roxburgh, 2 miles north of Limekilns, 16 miles north-west of Bathurst. O.T. 98/194; W.J.C. Ross, Journ. Roy. Soc. N.S.W., XXVII, 94/289; M.R. No. 25, 19/12, 124, 320; R. 94/60. *Limestone, Marble.*

Parish of Wiagdon, 2 miles west of Limekilns. R. 95/17. *Gold.*

Blackman's Swamp. R. 85/50. *Gold.*

Clear Creek, parish of Eskdale. R. 75/59, 81/36, 98/28, 00/15, 104, 01/13, 83, 02/13, 03/11, 04/11, 06/15, 07/17, 08/15, 09/15, 10/15. *Gold.*

LIMEKILN WATERHOLE. Parish of Dromore, county of Nicholson, 60 miles south of Wilcannia. *Limestone.*

LIMESTONE CREEK. [*See* Belubula River, Binalong, Boorowa, Bungonia, Captain's Flat, Cudgegong, Dunedoo, Dungog, Goodradigbee River, Limekilns, Macquoen, Muswellbrook, Queanbeyan, Tenterfield, Wollondilly River, Yass.]

Parish of Ollera, county of Hardinge, south-west of Ben Lomond, 28 miles south-east of Inverell. M.R. No. 25, 19/253. *Limestone.*

LIMESTONE FLAT, now Portland. [*See.*]

LIMESTONE GULLY. [*See* Attunga and Tingha.]

LIMESTONE OAKY CREEK. [*See* Nundle.]

Digitized by Google

LIMESTONE PLAINS CREEK AND RESERVE. [*See* Parkes.]
LIMESTONE VALLEY CREEK. [*See* Cargo.]
LIMESTONE WATERHOLES. [*See* Boorowa.]
LIMESTONE WELL. Parish of Morton, county of Fitzgerald, 45 miles north of White Cliffs.
LIMESTONES. [*See* Mudgee.]
LINCOLN'S CREEK. [*See* Muswellbrook.]
LINDSAY MOUNT. [*See* Orange.]
Macpherson's Range, Queensland Border, parish of Unumgar, county of Rous. J.E.C. M.R. No. 6, 08/191. *Copper.*
LIONSVILLE AND SOLFERINO. Gnarcoco or McGrath's Creek, parish of Churchill, county of Drake. C.S.W. 89/202; R. 75/112, 90/119, 04/21, 05/16, 06/20, 11/23, 12/20, 13/23, 14/23, 15/21, 95, 16/20, 17/17; R. 98/52 (alluvial gold); Dredge, 01/36, 02/31. *Gold.*
Shellmallier. M.P. 82/86; R. 78/132. *Gold, Silver, Galena, &c.*
Pauls, Collum Collum, and Washpool Creeks, Horseshoe Bend, Clarence River, parishes of Carngham, Keybarbin, &c. J.E.C. M.R. No. 16, 12/3, 25, 30, 39, 46; M.P. 82/99; R. 75/113, 90/119, 05/52. *Antimony, Silver.*
Nogrigar Creek, parishes of Ewingar, Carngham, &c. T.W.E.D. Pros. B. paper, 91/279; J.E.C. 95/141, 99/175; M.R. No. 7, 13/27, 28; E.F.P. M.R. p. 278; R. 90/119, 96/50; Assay, 14/67, 15/63, 16/63. *Mercury.*
Ewingar Creek, parish of Ewingar. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 270; M.P. 82/105; R. 75/113. *Bismuth, Iron.*
J.E.C. M.R. No. 6, 08/187, 191, 192; R. 75/113, 05/16, 07/54, 08/49. *Copper.*
Malara Scrub, Marcolini's Claim, Millera, &c., parishes of Hong Kong and Malara, 5 miles north-west of Lionsville. C.S.W. 89/202; R. 88/115, 89/129. *Gold.*
Nicholson's Creek, parish of Hong Kong, 8 miles north-west of Lionsville. R. 85/96. *Gold.*
Yugilbar Pucka lodes, parish of Yulgilbar, county of Drake, 8 miles south-east of Lionsville [*See* Gordonbrook.] J.E.C. 07/169; M.R. No. 16, 12/39, 42; M.R. No. 15, 12/63; M.P. 82/100; R. 07/62; Assay, 07/176. *Antimony, Wolfram.*
J.E.C. M.R. No. 7, 13/17; R. 02/57. *Mercury.*
J.E.C. M.R. No. 6, 08/193. *Copper.*
R. 98/52, 05/13. *Gold.*
LISCOMBE PONDS CREEK. [*See* Belubula.]
LISMORE. [*See* Coal Index.]
Wyrallah, Richmond River, parish of East Gundurimba, county of Rous, 6 miles south of Lismore. G.A.S. 95/173; E.F.P. M.R. p. 429; G.W.C. and W.S.D., Rec. V, pt. 3, 97/143; R. 95/69, 96/51, 00/67, 02/59, 16/62. *Tripolite.*
LISTON. [*See* Wilson's Downfall.]
LITHGOW. [*See* Coal Index.]
Parish of Lett, county of Cook. J.E.C. Mem. G. 6, 08/238, 239, 241; E.F.P. M.R. p. 436; R. 15/64; Assay, 06/178; R. 17/56, 18/64. *Fire and Potter's Clay.*
J.E.C. 92/148; M.P. 82/108. *Iron in Coal Measures.*
The Gap. R. 18/36. *Silver.*

Digitized by Google

LITTLE BOG. Victorian Border, parish of Lawson, county of Wellesley. R. 90/80. *Gold.*

LITTLE BILLABONG. [*See* Hillside.]

LITTLE CURRAGH. [*See* Curragh.]

LITTLE DARLING SPRINGS. [*See* Broken Hill.]

LITTLE FOREST. [*See* Coal Index.]

LITTLE MANNING. [*See* Copeland.]

LITTLE NYMBOIDA RIVER. [*See* Coramba.]

LITTLE OAKEY CREEK. [*See* Wattle Flat.]

LITTLE PLAINS RIVER. County of Wellesley, east of Delegate. R. 95/23. *Gold.*

LITTLE PLANT CREEK. [*See* Vegetable Creek.]

LITTLE RIVER. [*See* Braidwood, Boyd River, Burraga, Mongarlowe, Wangat, Yeoval.]

LIVERPOOL. [*See* Coal Index.]

LIVERPOOL PLAINS. Counties of Buckland and Pottinger. Rec. VI, pt. 4, 00/200, 207.

LOBBS HOLE. [*See* Ravine.]

LOCKSLEY. [*See* Yetholme and Bathurst.] Parish of Yetholme, county of Roxburgh, 15 miles east-south-east of Bathurst. J.E.C. M.R. No. 6, 08/150; R. 81/36, 12/48, 13/51, 14/53. *Gold. Silver, Copper.*

LOCKYERSLEIGH. [*See* Goulburn.]

LODE HILL. [*See* Kookarabooka.]

LOG PADDOCK. [*See* Mudgee.]

LOMOLONG. [*See* Bungendore.]

LONDON BRIDGE. [*See* Queanbeyan and Captain's Flat.]

LONESDALE'S CREEK. [*See* Nerrigundah.]

LONG BAY, Sydney. J.B.J. 02/128. *Ironstone.*

LOOK DOWN. [*See* Bungonia.]

LORIGAN MT. [*See* Noorooma.]

LOUISA CREEK AND LOUISA PONDS CREEK. [*See* Hargraves.]

LOWTHER. Parish of Lowther, county of Westmoreland, 10 miles west of Mt. Victoria. J.E.C. M.R. No. 6, 08/150; Assay, 97/191. *Copper, Silver.*
E.C.A. M.R. No. 24, 16/133; L.J.J. 17/171. *Molybdenite.*

LOWRY CREEK MT. Parish of Warrabah, county of Darling, 24 miles east-south-east of Barraba. M.P. 82/103. *Tin.*

LUCKNOW. [*See* Orange.]

LUE. Parishes of Arthur and Dungeree, county of Phillip. R. 02/61, 13/66, 14/67, 214, 16/62. *Barytes.*
T.W.E.D. 91/212; J.B.J. Mem. G. 2, 1901; L.F.H. 12/181. *Iron.*
M.R. No. 25, 19/307. *Limestone.*

LUMPY SWAMP (or Lunday). [*See* Carcoar.]

LUNATIC. [*See* Drake.]

LYNDHURST. Parishes of Belubula and Lyndhurst, county of Bathurst, 8 miles west-south-west of Carcoar. E.F.P. M.R. p. 53, 63; Rec. VII, pt. 1, 00/9; R. 85/53, 99/21, 03/13, 05/12, 07/19, 08/16, 09/16, 10/17, 11/18, 12/16, 13/17, 14/18, 15/17, 16/16, 18/77. *Gold.*

Digitized by Google

MACKDONALD RIVER. Head of River, south-south-west of Walcha, county of Vernon. J.E.C. M.R. No. 16, 12/40. *Antimony.*
Rec. VI, pt. 4, 00/214, 226; R. 94/30, 95/28. *Gold.*

MACINTYRE RIVER. [*See* Tingha.]

MACKSVILLE. [*See* Nambucca.]

MACLAUGHLIN CREEK. [*See* Nimmitabel.]

MACLEAN. [*See* Woogoolga.]
Clarence River, county of Clarence, 10 miles south of Maclean. Assay, 06/178. *Chromite.*

MACLEAY HEADS. Beach Sands. Assay, 12/195. *Gold, Silver.*

MACLEAY RIVER. [*See* Carrai.] Long Flat, 60 miles above Kempsey. J.E.C. M.R. No. 6, 08/263. *Copper.*
Long Flat, Pee Dee, &c., 40 miles above Kempsey. C.S.W. 89/205. *Tin, Gold, Molybdenite.*
Kunderang, Parish of Kunderang, county of Vernon. R. 00/59. *Tin.*
Kunderang Brook, parish of Loch, 42 miles east of Walcha, south-west of Willi Willi. M.R. No. 25, 19/328. *Limestone.*
Moparrabah. Upper Macleay River. R. 01/67, 02/59; M.R. No. 25, 19/222. *Marble.*
Macleay River. Half-way between Armidale and Kempsey. Assay, 02/131. *Arsenic, Silver.*

MACQUARIE PORT. [*See* Wauchope.] Hastings River, Nobbys, parish of Macquarie, county of Macquarie. J.E.C. 96/107, 97/150; Rec. V, pt. 2, 1897. *Copper, Iron Sulphide, Silver* (trace), *Kerosene* reported.
R. 81/94, 07/60, 10/54, 11/60, 12/57, 14/61, 15/56, 17/49, 18/48; Assay, 07/182. *Iron Oxide, Red Ochre.*
3 miles south, 10 miles south-west, 12 miles west of Port Macquarie. J.E.C. 96/106; M.R. No. 1, 1898; R. 05/50; Assay, 03/141, 13/189. *Mag. Iron, Cromite.*
Town and Cliffs. J.B.J. 97/177; J.E.C. 96/106; E.F.P. M.R. p. 229; M.P. 82/118; R. 87/94, 93/49, 98/75, 03/55, 04/54. *Cobalt.*
Beach. J.E.C. 96/104, 06/21; Rec. V, pt. 2, 97/52. *Gold.*
Tacking Point. M.P. 82/86. *Silver.*
6 to 14 miles west of Port Macquarie. Assay, 06/178, 07/176. *Arsenic.*
Morton's Creek, Hastings River, parish of Redbank, 15 miles west of Port Macquarie. Assay, 06/180. *Manganese.*
Wilson River, parish of Kippara, 30 miles north-west of Port Macquarie. R. 16/48. *Copper.*

MACQUARIE RIVER. [*See* Hill End, Muckerwa, Stuart Town; Wellington, &c. J.B.J. 94/143; M.P. 82/23; Rec. VI, pt. 4, 00/242; L.F.H., Rec. VIII, pt. 4, 09/327; Dredge, 01/35, &c.; R. 95/19. *Gold.*
E.F.P. M.R. p. 410; M.P. 82/122. *Gold, Sapphires, Diamonds.*
Assay, 06/181. *Platinum.*
Ningala Creek, county of Bligh. R. 95/19. *Gold.*
Suttor's Long Point, parish of Trianbil, county of Wellington. J.E.C. 16/205. *Gold.*

MACQUEEN. [*See* Denison or Moonan Brook.]
Limestone Creek, Apple Tree Camp, Pigna Barney River, parishes of Tomalla, Currickabark and Myra, county of Hawes, 18 to 25 miles north-east of Macqueen. M.R. No. 25, 19/253. *Limestone.*

Digitized by Google

MAIN RIDGE. [*See* Rockley.]

MAITLAND. [*See* Coal Index.]

M.P. 82/109. *Iron.*

Blair Duguid Hill, parish of Allandale, county of Northumberland, 10 miles west of Maitland. M.R. No. 25, 19/299. *Concretionary Limestone.*

MAITLAND BAR. [*See* Hargraves.]

MAJOR'S CREEK. Back and Bell's Creeks, Berlang, Jembaicumbene, Rigby, and Snob's Reefs, parishes of Elrington and Seymour, county of St. Vincent. W.A. 92/121; J.B.J. 97/174, 02/125; T.W.E.D. and E.F.P. 02/121; E.F.P. M.R. p. 24, 62; Rec. VI, pt. 4, 00/195, 196, 214; R. 75/46, 83, 76/96; 79/119, 90/83, 91/99, 95/24, 96/67, 02/25, 03/22, 04/23, 05/21, 06/22, 84, 07/24, 81, 08/21, 09/21, 11/24, 13/24, 85, 14/25, 84, 15/23, 83, 16/22, 17/17, 18, 18/17, 79; Dredge 05/25, &c., to 16/25, 17/21, 18/19. *Gold.*

J.B.J. 97/174; J.E.C. M.R. No. 6, 08/361, 363, 368; R. 90/87. *Gold, Silver, Copper, Antimony.*

Red Hill. R. 88/89. *Gold, Silver.*

Harold's Cross. R. 17/55, 18/62. *Barytes.*

MAJOR MOUNTAIN. [*See* Bombay Creek, Braidwood.]

MAKIN'S CREEK. [*See* Wagonga, under Noorooma.]

MALACCA. [*See* Inverell.]

MALACHI HILL. [*See* Cudal.]

MALARA SCRUB. [*See* Lionsville.]

MALLE TANK. [*See* Cobar.]

MALONGULLI. [*See* Belubula River.]

MANARA MOUNT. Parish of Manara, county of Manara, 70 miles south-east of Wilcannia. *Gold.*

MANBUNDI MOUNTAIN. [*See* Deepwater.]

MANDAGERY CREEK. [*See* Molong.]

MANDAMAH. Broken Dam, parish of Langi Kal Kal, county of Bourke, 23 miles north-west of Temora. C.S.W. 81/138; G.A.S. 89/234; J.E.C. M.R. No. 14, 11/276; R. 88/78. *Tin.*

MANDURAMA. [*See* Belubula River.]

Cliefden Station. M.R. No. 25, 19/177, &c. *Limestone.*

Gally Swamp, Plum Pudding Creek, Gallymont, parish of Somers, south of Mandurama. C.S.W. 78/150; R. 85/50, 87/50, 88/61, 93/20, 94/20, 96/25, 97/28, 98/27, 01/83, 08/16, 10/16. *Gold.*

Junction Reefs, parish of Belubula, county of Bathurst, 5 miles west-north-west of Mandurama. T.W.E.D. 90/239; Rec. VI, pt. 4, 00/205; R. 97/81, 03/13, 04/12, 05/12, 06/17, 07/19, 08/16, 09/16, 10/17, 11/18, 12/16, 13/17, 14/18, 87, 15/17, 16/16, 17/14, 18/12. *Gold.*

4½ miles north-west of Mandurama. J.E.C. M.R. No. 6, 08/151. *Copper.*

Parishes of Walli, Malongulli, Lyndhurst, and Hampton. J.B.J. Mem. G. 2, 01/128, 158; J.E.C. 92/149; E.F.P. Iron Ore Deposits of N.S.W., 1910. *Iron in Limestone.*

Assay, 16/210. *Barytes.*

MANGOPLAH. [*See* Pulletop.]

Digitized by Google

MANILDRA. Cumble or Goonigal Creek, Gumble, parish of Cumble, 10 to 14 miles south-west of Molong, 4½ miles north of Manildra. R. 15/17. *Gold.*
C.S.W. 86/133; J.B.J. Mem. G. 2, 01/135. *Iron.*
J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 265; R. 87/45, 63; Assay, 03/140. *Bismuth.*
Parishes of Cumble and Manildra. C.S.W. 86/132; J.E.C. M.R. No. 6, 08/145, 281; M.R. No. 14, 11/299; E.F.P. M.R. p. 131; R. 87/63, 88/75 *Copper, Silver, Tin, Antimony (trace).*
Parish of Manildra, 5 miles north-west of Manildra. E.C.A. M.R. No. 24, 16/119; M.M. 16/211. *Molybdenite.*
Parish of Brymedura. 5½ miles north-east. M.R. No. 25, 19/161. *Limestone.*

MANILLA. Hall's Creek, &c., county of Darling, north-east of Manilla. J.E.C. 97/149, 150; M.R. No. 1, 1898; R. 17/55; Assays 02/131, 03/140, 07/177. *Chromite.*
W.A. 88/182. *Gold.*
J.E.C. M.R. No. 16, 12/40. *Antimony.*
15 miles from Manilla, 1½ miles from Crow Mountain road. J.E.C. M.R. No. 15, 12/81. *Sheelite.*
Halls' or Cuerindi Creek, near Wiseman's Arm, parishes of Hall and Halloran, 12 miles east of Manilla; Yarrambulla Creek, parishes of Cuerindi and Halloran, county of Darling, parish of Burdekin, county of Inglis, 5 to 9 miles south-east of Manilla. M.R. No. 25, 19/218. *Limestone.*

MANLY, county of Cumberland. Quarantine Reserve. R. 75/139; J.B.J. Mem. G. 2, 01/105. *Ironstone.*
Assay, 06/179. *Fireclay.*

MANN RIVER. [*See* Glen Innes, Kingsgate, and Mitchell.]
Between Glen Innes and Dalmorton and Newton Boyd. Rec. VI, pt. 4, 00/201; R. 98/53, 02/16, 08/20, 09/20, 14/24. *Gold.*
J.E.C. M. R. No. 6, 08/192. *Copper, Silver, Lead, Gold (trace).*

MANNAFIELD. [*See* Goulburn.]

MANNA HILL. [*See* Stuart Town.]

MANNING RIVER. [*See* Nowendoc, Taree, and Wingham.]

MARAGLE. [*See* Tumbarumba.]

MARANGAROO. County of Cook. J.E.C. Mem. G. 6, 08/240; R. 14/68, 15/64, 16/63, 17/56. [*See* Bowenfels for silica.] *Fireclay.*

MARANGLE CREEK. [*See* Cowra.]

MARBLE CREEK. [*See* Indi R.]

MARBLING SPRINGS. [*See* Pulletop.]

MARENGO (Murringo). [*See* Young.]
South boundary, county of Gresham, 18 miles from Guy Fawkes. R. 04/21. *Gold, Limestone.*

MARCOLINI CREEK. [*See* Lionsville.]

MARGARET'S CREEK. [*See* Michelago.]

MARKDALE, county of Georgiana, 12 miles south of Tuena. Assay 07/177. *Bismuth, Gold.*

MARLOWE. [*See* Braidwood.]

MAROBEE. [*See* Euabalong.]

MAROUBRA. County of Cumberland. M.M. 12/191. *Sandstone* (for building).

MARRANGAROO. [*See* Marangaroo.]

Digitized by Google

MARSDEN'S SWAMP. Parish of Lowther, county of Westmoreland.
Ganbenang Creek, 18 miles from Mount Victoria. L.J.J. 17/171.
Molybdenite.

MARSFIELD. Near Ryde, county of Cumberland.
Assay, 07/182. *Red Pigments.*

MARSHALL MCMAHON'S REEF. [*See* Harden.]

MARTIN'S CREEK. [*See* Paterson.]

MARULAN. Barber's Creek, parish of Marulan, county of Argyle, and 3 miles south-west of Old Marulan. R. 13/23. *Gold.*

Carrington Lode, 5 miles from Marulan, south side of road to Goulburn.
C.S.W. 86/131; J.B.J. Mem. G. 2, 01/131; E.F.P. Iron Ore deposits of N.S.W. 1910; J.E.C. M.R. No. 16, 12/40; Assay, 04/152; R. 05/50.
Gold, Silver, Iron, Antimony.

Jerrara. [*See* Bungonia.]
C.S.W. 86/131. *Silver.*
M.P. 82/171. *Slate.*
A. 07/178. *Cobalt, Manganese.*

Shelly's Flat, parish of Billyrambija, 3 miles west of Marulan.
J.E.C. M.R. No. 6, 99/154; Rec. VI, pt. 4, 00/199. *Copper, Gold.*
5½ miles from Marulan; R. 12/62; Assay, 02/129. *Yellow Ochre.*

Wollondilly River, parish of Billyrambija, 5 miles north-west of Marulan, parish of Marulan; Jerrara Caves, 4 to 7 miles south-south-east of Marulan.
C.S.W. 86/131; W.S.L. 90/311; M.R. No. 25, 19/12, 13, 125, 132, 139. *Limestone, Marble.*

Talwong. Shoalhaven River, parish of Borimbadal, county of St. Vincent, 9 miles south-south-east of Marulan.
J.E.C. M.R. No. 6, 08/366, 367, 413; M.R. No. 14, 11/344.
R. 07/54, 81, 08/49, 09/48, 10/43, 48, 11/47, 53, 58, 12/49, 13/53; *Copper, Tin, Silver, and Gold* (traces).
R. 08/60. *Arsenic.*
W. G. Woolnough, Proc. Linn. Soc. N.S.W. Vol. XXXIV, pt. 4, 1909.

MARYLAND. [*See* Wilson's Downfall.]

MARYVALE. [*See* Wellington and Coal Index.]

MATONG. [*See* Paupong.]

MAUD MOUNT. [*See* Rockley.]

MCAULEY'S. [*See* Woodburn.]

MCDONALD MOUNT. [*See* Cowra.]
Mount McDonald, parish of Dunleary, 16 miles east-south-east of Cowra.
Scrubby Rush, parish of Tintern, county of Bathurst, north-west of Mount McDonald, south-east of Woodstock.
E.F.P. 93/102; R. 80/84, 81/35, 37, 40, 82/39, 106, 84/112, 90/65; R. 91/71, 95/16, 03/13, 04/12, 05/12, 06/17, 07/19, 08/17, 09/16, 10/17, 11/18, 12/16, 13/17, 14/18, 15/17, 16/16. *Gold.*
Township, &c.
J.E.C. M.R. No. 6, 08/142, 159, 169; R. 03/47. *Copper.*
Green Mantle. R. 91/72. *Gold.*
Milburn Creek, parish of Dunleary, 1½ miles north of Mount McDonald.
J.E.C. M.R. No. 6, 08/151; R. 75/65, 78/23, 80/219, 00/54.
Copper.

Digitized by Google

Oaky Creek, Grabine. Parish of Purfleet, north-east and east of Mount McDonald. *Gold.*

Rocky Bridge Creek, parishes of Egbert and Roseberg, north-east of Mount McDonald, 12 miles south-east of Lyndhurst.
C.S.W. 77/207; W.A. Rec. III, pt. 1, 1892; M.P. 82/179; R. 05/49. *Opal.*

Near Abercrombie River. R. 01/59. *Diamonds.*

Peisley's Creek, parish of Roseberg, 8 to 11 miles north-east of Mount McDonald; Butcher's Creek, 8 miles east. R. 90/65. *Gold.*

McDONALD'S HOLE. [*See* Coal Index, Brogan's Creek and Carlo's Gap.]

McGRATH'S CREEK. [*See* Lionsville.]

McLAUGHLIN RIVER. County of Wellesley. [*See* Nimmitabel.] J.E.C. M.R. No. 6, 08/365; Rec. VI, pt. 4, 00/197, 296. *Copper, Gold, Lignite.*

McLEOD'S CREEK. [*See* Bateman's Bay, Walcha, and Timbarra.]

McPHAIL. [*See* Tomingley.]

McPHILLAMY'S HILL. [*See* Blayney.]

MEADOW LEE AND FLAT. [*See* Sunny Corner.]

MEGALONG. [*See* Coal Index.]

MEGLO. [*See* Tuena.]

MELROSE. [*See* Condobolin and Bora Creek.]

MELROSE RANGE. 29 miles north-west of Condobolin, parish of Melrose, county of Cunningham. M.R. No. 25, 19/216. *Limestone.*

MERAGLE. [*See* Maragle.]

MERAMBEGO. [*See* Delegate.]

MERIMBULA. [*See* Pambula.]

MERINDA, or Merindee. [*See* Hargraves.]

MEROO CREEK. [*See* Hargraves.]

MERRILLA. [*See* Breadalbane.]

MERYLA. [*See* Coal Index.]

MERYULA. Parish of Rochford, county of Robinson, 27 miles by road from Cobar.
J.E.C. M.R. No. 6, 08/247. *Copper.*

METZ. [*See* Hillgrove.]

MIANDETTA STATION. [*See* Hermidale.]

MICHELAGO. Parish of Micaligo, county of Beresford.
R. 12/14, 14/16. *Gold, Silver.*
Assay, 04/152. *Manganese.*
Micaligo Creek, Murrumbidgee River. Parish of Micaligo, county of Beresford. Parish of Monkellan, county of Murray, 2 to 5 miles north-east to north-north-west of Michelago. Parish of Yarara, county of Cowley, 7 to 12 miles north of Colinton.
J.E.C. and L.J.J. M.R. No. 25, 19/126, 190, 291; R. 15/63. *Limestone Marble.*

MIDDLE CREEK. [*See* Inverell and Sofala.]

MIHI. [*See* Bora.]

MILA. Parish of Mila, county of Wellesley; 14 miles south of Bombala.
J.E.C. 97/159, 171; M.R. No. 15, 12/61; E.F.P. M.R. p. 302. *Tungsten.*

MILBURN CREEK. [*See* Mount McDonald.]

MILLAH MURRAH. Parish of Millah Murrah, county of Roxburgh, 8 miles south-west of Sofala.
R. 81/37. *Slate.*

Digitized by Google

MILLTHORPE. [*See* Blayney.]
E.F.P. M.R. p. 302. *Tungsten.*

MILTON. [*See* Coal Index.] L.F.H. 18/158. *Quartzite.*

MILPARINKA. Parishes of Milparinka and Orr, county of Evelyn.
E.F.P. M.R. p. 16; Rec. IV, pt. 4, 1896.
R. 87/105, 95/30, 82, 04/11, 07/13, 12/11, 14/12, 15/12, 16/12. *Gold.*

Mount Poole, parishes of Rocky Glen and Milparinka, 9 miles north-west of Milparinka.
C.S.W. 87/137; R. 80/182, 81/106. *Gold.*

Mount Browne, Wamberriga Range, parish of Orr, 8 miles south-west of Milparinka; Whittabreena Range, Stringer's Hill, &c.
H.Y.L.B. 81/4; M.P. 82/24, 25; M.P. 87/30; C.S.W. 87/137; Rec. Vol. I, 1889–90; E.F.P. 94/112; Rec. IV, pt. 4, 1896; M.R. p. 6, 15.
R. 81/9, 82/98, 83/115, 84/108, 85/103, 86/103, 87/105, 88/120. 95/83, 03/11, 06/11, 10/12, 12/11, 13/12, 14/12, 15/12, 16/12, 17/11. *Gold.*

Warratta Range, north-east of Milparinka.
R. 89/125, 95/30, 99/49, 07/89, 18/10. *Gold.*

MINERAL HILL. [*See* Condobolin.]

MINGELO. [*See* Peak Hill.]

MINJARY RANGE. [*See* Gundagai.]

MIRROOL CREEK. [*See* Ardlethan and Grong Grong.]

MISERY MOUNT. [*See* Nundle.]

MISSIBOTTI. [*See* Nambucca.]

MITCHELL. Mitchell or Mann River; parish of Diehard, county of Gough, 24 miles east of Glen Innes, south of Glen Elgin. E.C.A. M.R. No. 24, 16/84. *Molybdenite.*

MITCHELL MOUNT. [*See* Kookarabooka.]

MITCHELL'S CREEK. [*See* Bodangora, Sunny Corner, and Wellington.]

MITCHELL OR MANN RIVER. [*See* Cangai, Glen Innes, and Newton Boyd.]

MITCHELL OR SARA RIVER. [*See* Kookarabooka.]

MITTAGONG. [*See* Coal Index.] Digger's Creek, Kangaloon, parish of Burke, county of Camden, 6 miles east of Mittagong. R. 95/26, 68. *Gold, Diamonds.*

Doudle's Folly Creek, parish of Mittagong. E.F.P. 93/102; R. 93/6. *Gems, Diamonds.*

Burradoo, Nepean River, &c. C.S.W. 90/210; E.F.P. M.R. p. 395; R. 89/78. *Gems, Diamonds.*

Fitzroy, parish of Jellore. J.B.J. 99/191; Mem. G. 2, 1901; E.F.P. M.R. p. 193; Rec. VI, pt. 4, 00/306. *Iron.*

Parishes of Berrima, Burragorang, Bong Bong, Colo and Mittagong. C.S.W. 90/209; E.F.P. 99/168; M.R. p. 199; Iron Ore deposits of N.S.W., 1910; J.B.J. 99/192; Mem. G. 2, 01/34, 54, 114, 158; R. 05/50, 07/60, 10/54, 12/57, 14/61, 15/56; Assay, 85/38. *Iron and Iron Oxide.*

J.B.J. Mem. G. 2, 01/48, 52; E.F.P. M.R. p. 448. *Chalybeate Spring.*

Nattai River, below Mittagong. C.S.W. 90/210. *Gold.*

Limestone Creek, parish of Bangadilly, 20 miles west of Mittagong, south-west of Joadja. M.R. No. 25, 19/203. *Limestone.*

Digitized by Google

MITTA MITTA. Parish of Mitta Mitta, county of Clarendon, 9 miles south of Bethungra. R. 86/67, 89/71. *Gold.*

MOGGS. [*See* Jacob's Swamp.]

MOGO. [*See* Bateman's Bay.]

MOLE CREEK. [*See* Coramba.]

MOLE TABLE LAND. [*See* Vegetable Creek.] E.C.A. 19/155. *Wolfram, Bismuth.*

MOLETON. [*See* Dorrigo.]

MOLONG. Jews or Nora Creek, Wologalong, parish of The Gap, county of Gordon, north-west and north-north-west of Molong. W.A. 88/183; R. 87/72, 88/81, 12/62, 14/68. *Gold.*

Kilonbutta Creek, parish of Bell, county of Ashburnham, 7 miles west of Molong. R. 87/72. *Gold.*

Sammy's Mount, parish of Warne, county of Wellington, north-east of Molong, near Euchareena. R. 87/63. *Gold.*

Parish of Dilga, county of Gordon, 11 miles north-west of Molong. R. 14/19. *Gold.*

Copper Hill, parish of Copper Hill, county of Wellington, north of Molong. C.S.W. 85/130; E.F.P. M.R. p. 152; J.E.C. M.R. No. 6, 08/138, 276; R. 03/47, 09/47. *Gold, Silver, Copper.*

Molong and vicinity, counties of Ashburnham, Gordon, and Wellington. [*See* Cudal and Delancy's Dyke. J.E.C. M.R. No. 6, 08/17, 270, 278, 281; Rec. VI, pt. 4, 00/242, 243; Assay, 96/144. *Copper.*

Weandre Creek, Bell River, parish of Three Rivers, county of Wellington, parish of Eurimbula, county of Gordon, 14 miles north of Molong. W.A. 88/183; J.E.C. M.R. No. 6, 08/302. *Copper.*

Parish of Gamboola, 6 miles south-east of Molong. L.J.J. 18/165. *Gold, Silver, Lead, Copper.*

Spring Creek, parish of Eurimbula, county of Gordon, 10 miles north of Molong. J.E.C. M.R. No. 6, 08/278. *Copper.*

Eurimbula, north-west of Molong, Garra, 9 miles south-west of Molong, Reedy Creek, Mount Buckley. C.S.W. 86/133, W.A. 88/183, J.B.J. Mem. G. 2, 01/134; Assay 14/214. *Iron.*

15 miles west of Molong. J.E.C. 97/150, M.R. No. 1, 1898. *Chromite.*

Molong. R. 15/64, 16/63; Assay, 16/223; M.M. 18/161. *Kaolin, Fireclay.*

Borenore, Gamboola, Boree Carbonne, &c., county of Ashburnham, J.E.C. 14/193, 209; Assay, 16/220. *Phosphates.*

Between Molong and Parkes. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 266; Assay 06/178. *Bismuth.*

2 miles west of Molong. C.S.W. 86/133. *Flagstones.*

Assay 12/195. *Barytes.*

County of Ashburnham, Molong Rivulet, Mandagery Creek, parishes of Bell and Molong, Boree Hollow and Reedy Creeks, parish of Molong, Bocoble Creek, parish of Brymedura, Walker and Wattle Creeks, Amaroo Railway Station, parishes of Boree Nyrang and Gregra, Boree Creek, Borenore Caves and Quarries, parish of Barton. O.T. Papers Mines Misc. 10/8935, 134; J.E.C. 14/193; M.R. No. 25, 19/118, 148, 151, 156, 169; R. 16/63, 18/63. [*See* Cudal.] *Marble, Limestone.*

Digitized by Google

County of Gordon, Doughboy and Burrawong Creeks, Myrangle, parishes of Burrawong, Eurimbula, near Cumnock, Burgoon, Wilga, and The Gap. M.R. No. 25, 19/242, 243, 249.

County of Wellington, Bell River, parishes of Three Rivers, Boomey, Gamboola, and Copper Hill, at to 13 miles north-north-east of Molong, Mullion or Caleula, parish of Mulyan, 5 miles north-west of Mullion Creek Station. [*See* Cumnock.]

Rev. W. B. Clarke, Geology of N.S.W., Letter 56 to the Col. Sec., 10th October, 1851. C.S.W. 86/133; M.M. 08/170; M.M. and L.J.J. 14/211; M.R. No. 25, 19/330, 334, 335, 340; R. 07/66, 09/60, 10/59. 11/66, 13/66, 14/67, 15/63. *Limestone.*

MOLONGLO RIVER. [*See* Canberra, Captain's Flat, and Queanbeyan.]

MONARO. Southern District, principally in the county of Beresford. Rec, VI, pt. 4, 00/196. *Gold.*

MONIA GAP. Lachlan Range, counties of Nicholson and Dowling, 26 miles south-east of Hillston. R. 13/14. *Gold.*

MONGA. Mountain south-east of Braidwood, county of St. Vincent. *Copper.*

MONGARLOWE. Budawang Range. R. 86/78. *Copper.*

Mongarlowe or Little River, parishes of Budawang and Mongarlowe, county of St. Vincent, 8 miles east-north-east to 14 miles north-east of Braidwood. J.B.J. 96/132; R. 75/45, 85, 76/97, 91/98, 95/24, 99/35, 06/22; R. 07/24, 08/21, 09/21, 11/21, 15/83; Dredge 01/34, 09/25, &c., to 16/25, 17/21, 18/17. *Gold.*

MONKERAI. Karuah River, north of Dungog, county of Gloucester. J.E.C. 07/169; R. 94/29, 95/26, 05/77, 06/21, 83, 07/23, 80, 11/23, 14/24, 15/22. *Gold.*

MONKEY HILL. [*See* Hill End.]

MONTREAL. [*See* Bermagui.]

MOOKALIMBIRA MOUNT. Golconda Mine, parish of Mookalimbira, county of Yanda, 34 miles north of Cobar. *Gold.*

MOOKERAWA. [*See* Muckerwa.]

MOOMBOOLDOOL. [*See* Narrandera.]

MOONAN BROOK AND FLAT. Dry Creek, Kangaroo Creek near Tomalla Station. R. 09/19, 11/55. *Gold.*

Denison, parishes of Moonan, Omadale and Prosper, county of Durham, 26 miles north-east of Scone. Rec. VI, pt. 4, 00/220; R. 86/82, 89/95, 90/102, 95/18, 97/46, 00/29, 02/76, 03/22, 04/22, 05/17, 77, 07/22, 09/19, 11/21, 55, 12/19, 13/21, 14/23, 15/20, 16/19. *Gold.*

Neild's Creek. J.E.C. M.R. No. 16, 12/41; Assay, 16/219. *Antimony.*

Neild's Creek Range, between Creek and Omadale Brook. R. 00/29. *Gold.*

Omadale Brook. R. 06/19. *Gold.*

Stewart's Brook, parishes of Old Castle and Prospero, 5 miles south-east of Moonan Flat. R. 81/81, 88/101, 89/96, 90/101, 91/110, 92/21, 95/28, 97/46, 00/29, 01/29, 05/77, 06/84, 10/20, 13/21, 14/23, 15/20. *Gold.*

Parish of Omadale, 8 miles north-east of Moonan. M.R. No. 25, 19/228. *Limestone.*

Digitized by Google

Moonbi. Moonboy Creek, parish of Moonbi, county of Inglis, 10 miles north-east of Tamworth. Rec. V.I., pt. 4, 00/200; R. 95/28. *Gold.*
M.P. 82/118. *Manganese.*
New England, Moonboy and Moore Creeks, parish of Perry, 5 miles north of Moonbi. Parishes of Moonbi and Gill, 8 miles north-east of Attunga. E.C.A. M.R. No. 24, 16/122. [*See* Kootingal.]
Molybdenite.
East of Tamworth. J.E.C. 92/146. [*See* Tamworth.]
Limestone, Marble.
District J.E.C. 97/150; M.R. No. 1, 1898. *Chromite.*

Moonbi Range. [*See* Giant's Den, under Bendemeer.]

Moonboy Reefs. Parish of St. David, county of Bathurst, 18 miles north-east of Orange, south of Hill End. *Gold.*

Moonebah. [*See* Kempsey.]

Moonebar. Richmond River. [*See* Coal Index.]

Mooney Mooney Range. [*See* Gundagai.]

Moore Creek. [*See* Moonbi and Tamworth.]

Moore Mount. [*See* Barraba.]

Mooren. [*See* Coonabarabran.]

Mootwingee. County of Mootwingee, 65 miles north-east of Broken Hill. J.E.C. M.R. No. 6, 08/101; R. 80/182, 81/106. *Copper.*

Moparrabah. [*See* Macleay River.]

Moppity. [*See* Young.]

Moredun Clerks' Creek. [*See* Bundarra.]

Morden Station. [*See* Kooningberry.]

Mordialloc. [*See* Trundle.]

Morgan Mount. [*See* Kingsgate.]

Morongla Creek. [*See* Cowra.]

Morphett's Creek. [*See* Corona.]

Morris Mount. [*See* Rockley.]

Morrisset. [*See* Coal Index.]

Morton's Creek. [*See* Port Macquarie.]

Moruya. Donkey Hill, Dwyer's, Wamban, Francis and Condoin Creeks, Yarragee, parish of Moruya, county of Dampier. R. 75/47, 82/62, 87/76, 78, 98/43, 99/36, 00/19, 03/23, 05/21, 07/24, 81, 08/21, 09/22, 11/25, 12/22, 14/25, 15/23, 16/22, 81, 18/17. *Gold.*
Donkey Hill. R. 95/25, 08/21, 09/22, 10/23, 13/24, 14/84, 17/19. *Gold.*
Cockroby Creek. R. 78/115. *Gold.*
Wamban and Dwyer's Creeks, parish of Bergalia, 3 to 4 miles south of Moruya. L.Y. 79/223; J.E.C. 94/115, 98/160; E.F.P. M.P. p. 89; R. 75/48, 76/100, 78/115, 79/123, 87/78, 91/93, 95/57, 96/32, 98/43; R. 99/36, 64, 00/19, 52, 08/41, 87, 09/22, 10/23, 11/47, 12/43, 79, 13/46, 15/83. *Silver with Gold.*
Turlingah, parish of Congo, 10 miles south of Moruya. R. 89/82, 95/25, 96/32, 97/41, 10/23, 13/25. *Gold.*
Donkey Hill. Assay 07/180. *Iron.*
Parishes of Moruya and Congo, 5 miles east-south-east of Moruya. L.F.H. 10/180. *Ochre.*
R. 09/59. *Arsenic.*
Broulee, parish of Tomaga, county of St. Vincent, 3 miles north of Moruya. M.P. 82/86; R. 11/25.
Silver with Cobalt, Zinc and Iron.

Digitized by Google

Morven Creek. [*See* Five Bull.]

Mosquito Creek [*See* Drake and Dalmorton.]

Moss Vale. Parish of Bong Bong, county of Camden. J.E.C. 07/165; R. 07/23. *Gold.*

Parish of Bangadilly. R. 14/54. *Copper.*

Mountain Creek. [*See* Holbrook.]

Mountain Maid Creek. [*See* Copeland.]

Mountain Run. [*See* Rockley and Trunkey.]

Mount Boppy. [*See* Canbelego.]

Mount Hope. [*See* Hope.]

Mouramba. [*See* Nymagee.]

Mowabla. [*See* Condobolin.]

Mowamba. [*See* Jindabyne.]

Muckerwa Creek. Parishes of Muckerwa and Burrandong, county of Wellington, north-east of Stuart Town. Votes and Proceedings, Legislative Council, 1851/273-9; J.E.C. M.R. No. 7, 00/10; E.F.P. p. 275. *Mercury.*

C.S.W. 90/205; J.B.J. 94/143; Rec. VI, pt. 4, 00/224, 227; R. 06/17, 12/17. *Gold.*

C.S.W. 76/164. *Diamonds.*

Mudgee. County of Phillip. Log Paddock, parishes of Eurundury and Wilbetree, 7 miles north to south-east of Mudgee; C.S.W. 76/171, 86/136; J.E.C. 99/172; R. 76/45, 98/32, 09/17. *Gold.*

Bara Creek and Gap, parishes of Bara and Boogledie; Havilah, 12 miles east of Mudgee. C.S.W. 86/135, 136; E.F.P. 81/139; R. 80/95

Rats' Castle. R. 00/16. *Gold.*

Budgee Budgee, parish of Eurundury, 7 miles north-north-east of Mudgee. C.S.W. 86/135; R. 75/71, 79/80, 08/17, 11/19, 13/19, 14/20. *Gold.*

C.S.W. 86/138; L.F.H. 09/183, 12/181; Assay, 04/152, 180, 181, 182. *Manganese, Iron.*

J.E.C. M.R. No. 16, 12/30; A. 06/176. *Antimony.*

Pipe Clay Creek, parish of Boogledie, 7 miles east-north-east of Mudgee. C.S.W. 86/135; R. 78/69, 04/18. *Gold.*

Assay, 16/220. *Iron.*

Slasher's Flat, parish of Galambine, half-way between Mudgee and Gulgong. R. 95/18, 00/16. *Gold.*

Parish of Wilbetree, 9 miles north-west of Mudgee. J.E.C. M.R. No. 6, 08/303. *Copper.*

Between Mount Frome and Cudgegong River, parish of Bumberra, 2 to 3 miles east and north of Mudgee. C.S.W. 86/138; M.R. No. 25, 19/304. *Limestone.*

Lawson's Creek, near Havilah. C.S.W. 76/171. *Gold.*

Havilah (Buckaroo), Lawson's Creek, The Limestones, parishes of Derale and Boogledie, 7 miles east of Mudgee. L.J.J. 14/209; M.R. No. 25, 19/304, 306. *Limestone.*

Budgee Budgee, parish of Eurundury, 8 miles north-north-east of Mudgee. R. 15/57; M.R. No. 25, 19/127, 309. *Limestone.*

Counties of Phillip and Wellington, Cudgegong River, Mullamuddy, parishes of Broombee and Arthur. R. 77/71, 04/19, 06/17, 09/17, 10/18. *Gold.*

Digitized by Google

County of Wellington, parish of Mudgee. Rec. VI, pt. 4, 00/243; R. 06/18, 07/20. *Gold.*

Parish of Munna, 4 miles north-west of Mudgee. M.R. No. 25, 19/335. *Limestone.*

Apple Tree Flat. Log Paddock, parish of Broombee, 12 miles south-east of Mudgee. R. 81/46, 84/63. *Gold.*

Broombee, 12 miles south-east of Mudgee. R. 81/46, 84/63. *Gold.*

Broombee, 7 to 10 miles south-east of Mudgee. C.S.W. 86/135, 138; M.R. No. 25, 19/331, 340. [*See* Cudgegong.] *Copper, Gold, Limestone.*

Avisford, south-south-west of Mudgee, near Hargraves. *Gold.*

Mount Blatchford, Mount Morris, 10 miles south and south-east of Mudgee. C.S.W. 86/135. *Gold, Silver.*

Eurudgere, Green Swamp, Cullenbone, Rat's Castle, &c., 8 to 10 miles north-west of Mudgee. R. 80/100, 93/20, 97/30, 00/16. *Gold.*

Grattai, Oaky Creek, parish of Grattai, 12 miles south-west of Mudgee. R. 75/74, 77/72. *Gold.*

Parish of Werouera, 8 miles south-west of Mudgee. J.E.C. 15/175; R. 17/57. *Slate.*

Beau Desire, 13 miles north-west of Mudgee. R. 01/16. *Gold.*

District. R. 92/49, 11/66, 15/62, 17/55; Assay, 07/182. *Pigments, Barytes.*

Mount Buckaroo. M.M. 18/161. *Pottery Clay.*

Rec. VI, pt. 4, 00/298, 300. *Diamonds.*

R. 11/65. *Steatite.*

M.P. 87/122. *Graphite.*

J.E.C. M.R. No. 7, 13/17. *Mercury.*

Parish of Mudgee, 1 mile south-west of Mudgee, Cudgegong River, parishes of Brombee, Warratra and Tunnabutta, 5 to 12 miles south-east of Mudgee. M.R. No. 25, 19/332. *Limestone.*

MULGA SPRINGS. [*See* Broken Hill.]

MULGOWRIE CREEK. Parishes of Julong and Markdale, county of Georgiana, 16 miles south of Tuena. R. 97/28. *Gold.*

MULGUNNIA. [*See* Trunkey.]

MULLAH CREEK. [*See* Swamp Oak.]

MULLAMUDDY. [*See* Mudgee.]

MULLANJANDRA or Cumberoona. [*See* Albury.]

MULLION. Parish of March, county of Wellington, 9 miles north of Orange. Rec. VI, pt. 4, 00/227; R. 15/15. *Gold.*

Mullion Creek, Palmer's Bulga. R. 16/15. *Gold.*

Parish of Mulyan, west of Railway, 2 miles north of Mullion Station. *Silica.*

MULLOON CREEK. [*See* Fairy Meadow, under Bungendore.] Parish of Mulloon, county of Murray, 10 miles east of Bungendore. J.E.C. M.R. No. 6, 08/335, 336, 363, 364; R. 79/116, 99/34, 68, 06/48, 07/53, 12/50, 13/53, 14/54, 84, 16/43, 49; A. 04/151. *Silver, Copper.*

Parish of Palerang. R. 77/93. *Gold, Limestone.*

MULLUMBIMBY. [*See* Peters' Grass.]

Parish of Mullumbimby, county of Rous, 9 miles north-west of Byron Bay. J.E.C. M.R. No. 6, 08/191. *Copper.*

E.C.A. 04/146. *Gold with Silver.*

Assay, 04/152, 07/181. *Manganese.*

Digitized by Google

MULYAN. [*See* Yalgogrin.]
Parish of Mulyan, county of Wellington, north of Orange. J.E.C. M.R. No. 15, 12/84. *Sheelite.*

MUMBLE CREEK. Yarrowich Creek, county of Vernon, 30 miles south-east of Walcha. R. 89/99, 90/109, 91/117. *Gold, Silver, Copper.*

MUMMEL. [*See* Goulburn.]

MUMMUGA CREEK. [*See* Noorooma.]

MUNDI MUNDI. [*See* Purnamoota.]

MUNDOONEN. County of King, 10 miles south-west of Gunning. *Gold.*

MUNGA CREEK. Carangula, Macleay River, parishes of Willawarrin and Burragong, county of Dudley, 14 miles west of Kempsey. L.Y. 80/250; J.E.C. M.R. No. 16, 12/27, 28; M.P. 82/32, 100; R. 81/94, 83/99, 84/95, 06/83, 07/80, 176; A. 07/176. *Antimony.*

MUNGABARINA. [*See* Albury.]

MURGA. [*See* Cudal.]

MURRAMARANG. Sea Beach, parish of Turmeil, county of St. Vincent, 12 miles south of Ulladulla. R. 96/32, 98/42. *Gold.*

MURRAY'S HILL. [*See* Orange.]

MURRAY'S WATER. [*See* Tingha.]

MURRILL CREEK or Mirrool. [*See* Grong Grong.]

MURRINGO (Marengo.) [*See* Young.]

MURRUMBATEMAN. [*See* Yass.]
Nanima, parishes of Nanima and Morumbateman, county of Murray, 10 miles south-east of Yass. E.F.P. M.R. p. 268; J.A.W. M.R. No. 4, 1898; J.E.H.M. 06/175; Assay, 02/129, 132, 06/178, 07/182; R. 04/91, 08/58, 09/57, 10/56. *Bismuth, Gold and Silver.*
Nanima, 9 to 10 miles south-east of Yass. E.F.P. M.R. p. 65; J.A.W. 97/186; R. 84/78, 98/40, 99/34, 00/64, 06/15, 10/15, 15/24. *Gold.*
Assay 06/179. *Cobalt.*
Parish of Bedulluck, 18 miles south-east of Yass. R. 99/34. *Gold.*

MURRUMBIDGEE RIVER. [*See* Bredbo, Goodradigbee River, and Yass.]

MURRUMBIDGEE IRRIGATION AREA. Counties of Cooper and Livingstone. J.E.C. 16/190. *Gypsum, Limestone, Travertine.*

MURRUMBIDGEE RIVER BASIN. J.E.C. M.R. No. 6, 08/365. *Copper.*

MURRUMBOGIE. [*See* Fifield.]

MURRUMBURRAH. [*See* Harden.]

MURRURUNDI. [*See* Coal Index.]
Isis River, parish of Isis, county of Brisbane, 10 miles east of Wingen; Waverley Lodes, parish of Waverley, 17 miles east of Murrurundi; Timor, parish of Crawney. J.E.C. 06/167; R. 84/89, 119, 05/41. *Silver.*
Head of Isis River. J.E.C. M.R. No. 14, 11/294. *Tin.*
Isis River Caves, parishes of Crawney and Lincoln, county of Brisbane. M.R. No. 25, 19/196. *Limestone.*

MURWILLUMBAH. Bilambil Creek, parish of Terranora, county of Rous, 10 miles north-east of Murwillumbah. R. 02/16, 03/13, 14/24, 15/21. *Gold.*
Assay 04/152. *Manganese.*
Smith's Creek, parish of Dunbible, 4 to 7 miles south of Murwillumbah. R. 88/116, 08/20. *Silver, Gold.*
R. 09/60. *Kaolin.*
Nobby's Creek, parish of Kynnumboon, 5 miles north-west of Murwillumbah. R. 01/32. *Gold.*

Digitized by Google

MUSWELLBROOK. [*See* Coal Index.]

Upper Musclebrook, Head of Muscle, Lincoln, and Limestone Creeks, parishes of Balmoral, St. Aubins, and Herschell, county of Durham, 9 miles east-north-east of Muswellbrook. T.W.E.D. 86/145; J.B.J. Mem. G. 2, 01/82; M.R. No. 25, 19/227, 228. *Iron, Limestone.*

Kyuga, 4 miles north-west of Muswellbrook. Assay 07/180. *Iron.*

MUTTAMA. [*See* Coolac and Mooney Mooney Range.]

Parish of Mooney Mooney, county of Harden. T.W.E.D. Letter-book 90/258; Rec. VI, pt. 4, 00/234; R. 77/131, 82/75. *Gold.*

Assay 07/177, 180. *Iron, Chromite.*

MYALL. [*See* Peak Hill.]

MYALL CREEK. [*See* Bingara.]

MYALL LAKE, parishes of Topi Topi, Bullahdelah, and Eurunderee, county of Gloucester, near Bungwall, east of Bullahdelah, west-north-west and south of the Lake. R. 90/114, 99/80; Assay, 04/153; M.R. No. 25, 19/239. *Limestone.*

Paddy's Creek, parish of Topi Topi. *Gold.*

MYALL RIVER. Between Port Stephens and Bullah Delah, county of Gloucester. R. 98/79. Fireclay.

MYLORA. [*See* Binalong.]

MYRANGLE. [*See* Wellington.]

NACKA NACKA. [*See* Adelong.]

NADGEE, parish of Howe, county of Auckland, 8 miles north-west of Cape Howe. J.E.C. 97/156; R. 97/43. *Gold.*

NADGIGOMAR CREEK. [*See* Tarago.]

NAIL CAN RANGE. [*See* Albury.]

NAMBUCCA. [*See* Bowra and Bowraville.]

Butchers', Woy Woy, and Grant's Creeks, parish of Warrell, county of Raleigh, between Warrell Creek and Mount Yarrahapinni, 10 miles south of Nambucca, near Macksville. C.S.W. 89/205; R. 81/94, 18/80. *Gold.*

A. 12/195. *Barytes.*

L.Y. 80/251; M.P. 82/86; R. 88/106, 01/51, 15/47. *Silver.*

Assay, 12/195. *Antimony.*

L.F.H. M.R. No. 26, 17/11. *Felspar.*

E.C.A. M.R. No. 24, 16/127; R. 04/55, 05/53, 77, 18/80. *Molybdenite.*

Mount Yarrahapinni, parish of Yarrahapinni, county of Dudley. R. 81/94. *Silver.*

Missibotti, 8 miles west of Nambucca.

Bull Creek, county of Raleigh. J.E.C. M.R. No. 16, 12/27; R. 91/128. *Antimony.*

Deep Creek, parishes of Newry and Valley Valley, county of Raleigh, 8 miles north-north-west of Nambucca. C.S.W. 89/204; J.E.C. M.R. No. 16, 12/25, 40; R. 88/106, 95/26. *Silver, Gold, Antimony.*

Nambucca Heads. R. 92/20. *Gold, Silver.*

NAMOI RIVER. [*See* Barraba and Somerton.]

NANA. [*See* Coramba.]

NANDEWAR RANGE. [*See* Barraba.]

East Slope, county of Murchison. *Daily Telegraph* newspaper, 29/3/07. *Diamonds.*

Digitized by Google

NANGAHRAH CREEK. [*See* Barraba.]
NANGAR RANGE. [*See* Cudal.]
NANGERYBONE. [*See* Bobadah.]
NANIMA. [*See* Bodangora and Murrumbateman.]
NAPOLEON REEFS. [*See* Bathurst.]
NANGARIE RANGE AND RIVER. [*See* Dunedoo.]
NARELLAN CREEK. [*See* Narrallen under Boorowa.]
NARIBA. [*See* Bermague.]
NAROOMA. [*See* Noorooma.]
NARRABA CREEK. [*See* Boorowa.]
NARRABEEN. [*See* Coal Index.] J.E.C. M.R. No. 6, 08/63. *Cupriferous Shale.*
NARRABRI. [*See* Turrowan.] Eulah Creek, parish of Tippereena, county of Nandewar. R. 90/110. *Gold.*
Daily Telegraph, 5/4/00. [*See* Bullawa.] *Diamonds.*
Near Narrabri. R. 12/62, 17/57. *Fuller's Earth.*
6 miles east of Narrabri. *Tripolite.*
R. 15/56. *Iron Oxide.*
Ti Tree Creek, 12 miles from Narrabri. *Gold.*
NARRABURRA. [*See* Barmedman.]
NARRAGAL. [*See* Wellington.]
NARRALLEN CREEK. [*See* Boorowa.]
NARRANGULLEN. [*See* Cavan.]
NARRANDERA. Moombooldool, parish of Moombooldool, county of Cooper, 26 miles north of Narrandera, south-west of Ardlethan. R. 95/23, 00/25, 09/14, 17/12. *Gold.*
NARRIAH. [*See* Yalgogrin.]
NARRIGA. [*See* Nerriga.]
NARRI NARRI MOUNT. [*See* Bee Mount under Cobar.]
NARROMINE. Parishes of Frost and Wentworth, county of Narromine, south of town. R. 16/18. *Gold.*
Macquarie River. Assay 13/190. *Mag. Iron Ore with Platinum.*
NATIVE BEAR OR DOG CREEK. [*See* Grenfell.]
NATIVE DOG CREEK. [*See* Oberon.]
NATTAI. [*See* Coal Index and Mittagong.]
Parish of Berrima, county of Camden. M. P. 82/28, 108, 113. *Iron.*
NEEDLES, THE. [*See* Belubula River.]
NEILA CREEK. [*See* Cowra.]
NEILDS OR NEIL'S CREEK. [*See* Moonan Flat.]
NELBOTHERY RANGE. County of Wellesley, north of Delegate, 14 miles south-west of Bombala. R. 83/79, 94/28, 95/23. *Gold.*
NELLIGEN. [*See* Bateman's Bay.]
NELSON. [*See* Bega.]
NEPEAN RIVER. Parish of Nepean, county of Cook, head of river. Rec. VI, pt. 4, 00/202. *Gold.*
NERRIGA. Parish of Meangora, county of St. Vincent, 19 miles south-west of Yalwal. J.B.J. 98/171; Rec. VI, pt. 4, 00/195; R. 95/25, 03/22, 04/23, 07/24. [*See* Corang River.] *Gold.*
J.E.C. M.R. No. 16, 12/41. *Antimony* (reported).
NERRIGUNDAH. [*See* Noorooma.]
NERRINUNGA. [*See* Bungonia.]
NEVILLE. [*See* Carcoar.]

Digitized by Google

NEWBRIDGE. Dry Diggings, Sugarloaf, parish of Galbraith, county of Bathurst. E.F.P. 92/110; R. 92/17, 95/17, 97/28, 99/22, 00/14, 01/15, 15/17, 86. *Gold.*

Parish of Three Brothers, 1½ to 10 miles south of Newbridge. J.E.C. 94/116; J.B.J. 94/142. *Gold.*

Garibaldi Gully, half-way between Trunkey and Newbridge. R. 93/19. *Gold.*

Parish of Galbraith. J.E.C. 92/150; J.B.J. Mem. G. 2, 01/137; J.E.C. Mem. G. 6, 08/234; E.F.P. Iron ore deposits of N.S.W., 1910; Assay, 83/37, 02/131. *Iron.*

A. 02/130. *Asbestos.*

Parish of Bringellet, 8 miles east-south-east of Newbridge. J.E.C. M.R. No. 6, 08/160. *Copper pyrites.*

Newbridge. E.F.P. M.R. p. 429. G.W.C. and W.S.D., Rec. V, pt. 3, 97/147. *Tripolite.*

Assay, 16/220. *Yellow Ochre.*

NEWCASTLE. [*See* Coal Index.] M.P. 82/108. *Hematite, Fossil Trees.*

NEW CHUM HILL. [*See* Kiandra.]

NEW ENGLAND CREEK. [*See* Moonbi.]

NEWINGTON. [*See* Coal Index.]

NEWREA. [*See* Wellington.]

NEWRY. [*See* Nambucca.]

NEW STATION CREEK. [*See* Pambula.]

NEWSTEAD. [*See* Tingha.]

NEWTON BOYD. Barney's Hill, parish of Barool, county of Gresham, 6 miles north-east of Newton Boyd. R. 16/20. *Gold.*

Newton Boyd Road. R. 91/114. *Manganese.*

Mann River, parish of Cooraldooral, county of Drake, 10 miles north-east of Newton Boyd, west of Cangai. *Gold.*

R. 18/80. *Molybdenite.*

NEW VALLEY. [*See* Tingha.]

NIANGALA. Hall's Creek, Paradise, Terrible Billy, parish of Scott, county of Parry, 8 miles south of Niangala. G.A.S. 92/132; R. 91/118, 92/20, 93/23, 05/17, 06/19, 07/22, 08/19, 09/19. *Gold.*

G.A.S. 92/132; J.E.C. M.R. No. 16, 12/41, 46. *Antimony.*

Lever Creek, 6 miles south of Paradise. R. 01/28. *Gold.*

Niangala, parish of Walcha, 33 miles south-east of Tamworth. G.A.S. 92/127; Rec. III, pt. 2, 1892; R. 91/119, 95/28, 99/41, 06/84, 14/22, 15/20. *Gold.*

NICHOLSON'S CREEK. [*See* Lionsville.]

NIELD'S CREEK. [*See* Moonan Flat.]

NIMMITABEL. Parish of Nimmitabel, county of Wellesley. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 269; R. 88/94, 89/92. *Bismuth.*

Hydra. R. 16/15. *Gold.*

Thoko, parish of Thoko, 14 miles south-south-east of Nimmitabel. R. 88/94. *Gold, Silver, Tin.*

L.J.J. 17/170. *Wolfram.*

R. 07/175. *Ruby.*

Doyle's Brook, Bombala River, parish of Thoko, 12 miles south-east of Nimmitabel.

Maclaughlin Creek, parishes of Bungarby and Wangellic, 16 miles south-west of Nimmitabel. M.R. No. 25, 19/329. *Limestone.*

Digitized by Google

NINE MILE. [*See* Albury, Kiandra, Vegetable Creek, and Wyalong.]

NINGALA CREEK. [*See* Macquarie River.]

NITHOLM. [*See* Cooma.]

NOBBY MOUNT. [*See* Condobolin.]

NOBBY'S CREEK. [*See* Murwillumbah.]

NOGRIGAR CREEK. [*See* Lionsville.]

NOMBINNIE. [*See* Mount Hope.]

NOOGERA CREEK. [*See* Bingara.]

NOOROOMA. Bumbo, parish of Wamban, county of Dampier, north of Nerrigundah, 20 miles north-west of Noorooma. J.B.J. 03/127; R. 80/131, 98/44, 10/23, 11/25, 13/25, 14/26, 18/17. *Gold.*

Corunna, parish of Noorooma, 3 miles south of Wagonga Heads. R. 80/131, 98/44, 10/23, 11/25, 13/25, 14/26, 18/17. *Gold.*

Pankally or Punkally Creek, Dromedary Mount and Creek, and Tilba Tilba, parish of Noorooma, 8 miles south-west of Narooma. W.A. 90/264; R. 75/49, 77/12, 78/113, 80/132, 90/83, 99/37, 01/19, 03/23, 06/22, 84, 07/25, 80; R. 09/22, 10/23, 11/25, 13/25, 14/26, 84, 15/23, 16/22, 17/19, 18/17. *Gold.*

J.A.W. M.R. No. 4, 1898; E.F.P. M. R. p. 266. *Bismuth.*

Dignam's Creek, south-west of Mount Dromedary. R. 72/92, 12/23. *Gold.*

George Mount, 94/23. *Gold.* (poor).

Nerrigundah, or The Gulph, Lonsdale's Creek, parishes of Nerrigundah and Gulph, 15 miles north-west of Noorooma; Wet and Deep Creeks. J.B.J. 03/126, ; R. 75/48, 85, 88, 87/76, 91/93, 101, 98/43, 00/19, 02/25, 73, 03/23, 04/24, 90, 05/21, 78, 06/22, 84, 07/24, 08/21, 87, 11/25, 12/22, 13/25, 14/26, 15/23, 16/22, 17/19; Dredge, 05/26, 06/26, 07/28, 09/25, 12/25, 13/28, 14/29, 15/27. *Gold.*

Mount Coman, parish of The Gulph. R. 87/76, 77. *Gold.*

Mount Pleasant, Grass Tree, near Nerrigundah. R. 04/24, 05/21, 06/22, 09/22, 14/26, 84. *Gold.*

Tin Pot, Tuross River, parish of Urobodalla, 6 miles south of Nerrigundah. R. 85/76, 86/75, 91/93, 99/36, 01/19, 05/21, 06/22, 09/22, 10/23, 11/25, 14/26, 84, 16/22; Dredge, 03/30, 04/30. *Gold.*

Mount Utopia and Riverview, 2 miles south-west of Mount Utopia, parish of Cadgee, 10 miles south-south-west of Nerrigundah. J.B.J. 03/127; R. 00/19, 01/19, 84, 06/84, 07/24, 11/25. *Gold.*

Russell's Range, Quart Pot Creek, Wandellow, parish of Cadgee, 10 miles west of Wagonga, south of Nerrigundah. J.E.C. 94/116, 98/160; J.B.J. 03/127; R. 91/93, 14/26. *Gold.*

Wagonga, Mummuga, Makin's, Whittaker's, Kianga, Randol's, Punkalla Creeks, Lake Corunna, Rats Head or Burrumbidgee Creek, Mount Carrington, parish of Wagonga, west and north-west of Narooma. E.F.P. M.P. p. 65; R. 82/62, 86/76, 87/76, 90/89, 94/28, 95/69, 96/33, 97/42, 98/43, 99/36, 00/19, 01/19, 02/26, 03/23, 05/21, 06/22, 84, 07/25, 08/22, 11/25, 12/22, 13/25, 14/26, 18/17; Dredge, 03/30. *Gold.*

Wagonga Heads. J.B.J. 94/115; R. 82/67, 86/75, 94/28, 60, 97/42. *Gold.*

Mount Lorigan, parish of Wagonga. R. 92/69, 94/60. *Turquoise.*

Digitized by Google

No Place. [*See* Jingellic.]

Nora Creek. [*See* Molong.]

Norongo or Naiongo. [*See* Captain's Flat.]

Norris Mount. [*See* Mudgee.]

Norwood. [*See* Goulburn.]

Nowendoc. Brown's Creek, Cooplacurripa River, parish of Lowry, county of Hawes, 8 miles north-east to east-north-east of Nowendoc. Rec. VI, pt. 4, 00/200; R. 76/109, 95/27, 06/83. *Gold.*

Walsh's Creek, Cooplacurripa, north-east of Nowendoc. J.E.C. M.R. No. 6, 08/332; R. 83/89, 85/86. *Copper.*

Nowlands Creek. [*See* Kookarabooka.]

Nowra. [*See* Coal Index.]

15 miles south of Nowra, county of St. Vincent. Assay, 04/153. *Alum.*

Nubba. [*See* Wallendbeen.]

Nubrigyn Creek. [*See* Stuart Town.]

Nuggetty Gully. [*See* Glen Innes, Grenfell, Hargraves, Little River, Milparinka, Nerrigundah, Tingha, Tuena, &c.]

Nulla Nulla or Redland. [*See* Corowa.]

Nullamanna. [*See* Inverell.]

Numeralla. Late Umeralla. [*See.*]

Nundle. Peel River. Bowling Alley Point, 6 miles north of Nundle. Hanging Rock, 3 miles east of Nundle. Foley's Folley. Mounts Ephraim, Misery, Sheba, and Pleasant. Price's, Harden's Hills, &c. Oakenville, Swamp or Oaky and Quackanacca Creeks. Parishes of Nundle and Dungowan, county of Parry, 30 miles south-south-east of Tamworth.

C.S.W. 85/133, 135; J.B.J. 01/166; G.A.S. 92/127; Rec. VI, pt. 4, 00/199, 200, 207, 214, 230, 232.

R. 75/54, 94, 78/121, 80/145, 146, 82/78, 107, 87/90, 95/28, 97/45, 00/29, 01/28, 02/24, 03/21, 05/17, 06/19, 84, 07/22, 09/19, 10/20, 11/21, 12/19, 13/21, 14/22, 15/20, 16/19, 17/16, 18/15; Dredge, 06/27, &c., 10/27, &c., 14/31, 16/26, 17/21, 18/19. *Gold.*

Bowling Alley Point, 6 miles north of Nundle.

C.S.W. 91/215; E.F.P. 93/107; M.R. p. 285; J.E.C. 97/149; M.R. No. 1, 1898; M.P. 82/114; R. 10/20, 11/21, 17/55; Assay, 07/177. *Chromite.*

C.S.W. 85/135; J.E.C. M.R. No. 6, 08/318, 321, 328; R. 81/76, 78, 82/113, 84/90, 99/69, 13/54. *Copper, with Gold and Silver.*

Mount Pleasant, parish of Nundle. C.S.W. 85/135; R. 13/105. *Copper.*

Hanging Rock. J.E.C. M.R. No. 16, 12/3, 4, 41; M.P. 82/100; R. 75/96, 15/56. *Antimony.*

Happy Valley, Pennyweight Flat, &c.

M.M. 06/172; J.E.C. M.R. No. 15, 12/84; R. 07/64; assay, 06/181. *Tungsten.*

Woolomin, parish of Woolomin.

J.E.C. M.R. No. 15, 12/86. *Sheelite.*

Peel River. M.P. 82/119. *Nickel.*

R. 11/55; Assay, 04/150. *Bismuth, Silver, Copper.*

Digitized by Google

Vicinity of Nundle. E.F.P. M.R. p. 413; R. 96/143. *Zircons.*

Curator, 07/175. *Emery.*

Bowling Alley Point, north-north-west to Tamworth, near Peel River. M.R. No. 25, 19/300. *Limestone.*

Limestone, Oakey, and Wombramurra Creeks, parishes of Crawney and Wombramurra, 7 miles south-west of Nundle. M.R. No. 25, 19/290. *Limestone.*

W. N. Benson, Aust. Assoc. for the Advancement of Science, Vol. XIII, 1912.

NUNGATTA. [*See* Yambulla.]

NUNTHERUNGIE (Wertago). Cootawundy Range. Parishes of Wertago and Woraro, county of Yungnulgra, 70 miles north-west of Wilcannia.

J.B.J. 92/138, 01/168; J.E.C. M.R. No. 6, 08/92, &c.

R. 90/127, 91/138, 00/96, 04/46, 05/41, 44, 06/46, 07/51, 88, 08/46, 12/48. *Copper, Silver, Lead, and Gold.*

Grassmere. Parish of Daubeny, 9 miles south of Nuntherungie.

J.E.C. M.R. No. 6, 08/100; R. 96/127, 99/70, 06/92, 07/51, 88, 08/46, 12/48. *Copper.*

The Peak, Williams Creek, Broken Dam, parish of Williams, 10 miles north-east of Nuntherungie.

E.F.P. 94/112; Rec. IV, pt. 4, 1896; M.R. p. 17; R. 90/127. *Gold.*

Parishes of Byngnano and Nootumbulla, county of Mootwingee, 20 miles south-west of Nuntherungie. R. 07/51. *Copper.*

Bunker's Hill. R. 07/88. *Copper.*

NYMAGEE. Mouramba, parish of Priory Plains, county of Mouramba. L.Y. 80/261; J.E.C. M.R. No. 6, 08/254; E.F.P. M.R. p. 170; M.P. 82/26; R. 80/43, 14/100, 15/48, 96, 16/46, 95. *Copper.*

Crowl Creek, Shuttleton, Wirlong, parish of Hume, 14 to 18 miles south-west of Nymagee.

J.B.J. 01/165; J.E.C. M.R. No. 6, 08/211, &c., 261, &c. *Copper.*

Nymagee, Shuttleton, Wirlong, &c.

R. 80/218, 83/127, 84/120, 95/61, 98/101, 99/70, 00/57, 103, 01/53, 90, 02/48, 79, 03/46, 04/45, 89, 05/44, 80, 06/45, 07/50, 91, 08/45, 101, 09/46, 11/52, 89, 12/47, 93, 13/51, 102, 14/51, 102, 14/51, 102, 14/52, 100, 15/48, 16/47, 17/90. *Copper.*

Parish of Carlisle, between Shuttleton and Gilgunnia. *Copper.*

Babinda, parish of Babinda, county of Flinders, 9 miles north-east of Nymagee. J.E.C. M.R. No. 6, 08/216; R. 83/118; 14/52, 101. *Copper.*

Trowel Creek or Whitbarrow, 10 miles north of Nymagee. W.A. 87/164. *Gold.*

Parish of Beloura, county of Mouramba, 10 to 14 miles south-east of Nymagee. J.E.C. M.R. No. 6, 08/405; M.R. No. 25, 19/278. *Limestone.*

10 miles south-east of Nymagee. J.E.C. M.R. No. 15, 12/63. *Tungsten.*

District. E.C.A. M.R. No. 24, 16/132. *Molybdenite.*

District. J.A.W. M.R. No. 4, 1898; R. 95/65. *Bismuth.*

NYMBOIDA RIVER. [*See* Coal Index.]

County of Fitzroy; Assay, 03/141. *Manganese.*

NYMBOIDA, LITTLE. [*See* Coramba.]

Digitized by Google

OAKENVILLE CREEK. [*See* Nundle.]

OAKY CREEK. [*See* Copeton, Cobbadah, Nundle, Mudgee.]

OAKY CREEK, BIG AND LITTLE. [*See* Wattle Flat.]

OAKY PARK. [*See* Coal Index.]

OAKTON. [*See* Hillgrove.]

OAKWOOD. [*See* Kookarabooka.]

OALLAN CROSSING. [*See* Shoalhaven River.]

Parish of Oallen, county of Argyle. R. 87/72, 79. *Gold.*

OBAN. [*See* Kookarabooka.]

OBERON. Parish of Oberon, county of Westmoreland, 26 miles south-east of Bathurst.

Black Bullock Mount, &c., 3½ miles north-west of Oberon, head of Wiseman's Creek. Mount Gossan, 7 miles north-west.

C.S.W. 77/201, 11/17, 86, 12/16, 14/18, 84, 15/83, 16/16, 17/14.

R. 96/26, 97/23, 98/28, 99/23, 00/14, 53, 01/15, 51, 02/15, 03/46, 05/12, 18/12. *Gold.*

Native Dog Creek, parishes of Adderley, Baring, and Crete. R. 99/22, 09/16, 16/81. *Gold.*

Jelleindore. R. 10/17, 11/18. *Gold.*

Mount Baring (or Dad's Millions), Brisbane Valley Creek, parish of Baring, 8 miles west of Oberon. R. 11/17, 13/17, 14/18, 16/16. *Gold.*

Swallow's Nest. Sewell's Davy or Stony Creek. Parishes of Adderley and Irene. 12 miles west and south-west of Oberon.

C.S.W. 77/201; R. 95/17, 99/22. *Gold, Iron.*

Slippery Creek, parish of Blenheim, 5 miles north-east of Oberon. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 270; Assay, 96/143. *Telluride of Bismuth.*

R. 99/23, 00/14. *Gold.*

C.S.W. 77/201 plan. *Gems.*

Hazelgrove, 5 miles north of Oberon. Duckmaloi Creek and River, 6 to 8 miles south-east of Oberon. E.F.P. M.R. p. 271.

Assay, 99/193, 02/132, 06/178; R. 10/56, 16/81.

Duckmaloi River, parish of Kendall, 9 miles north-east of Oberon.

Parish of Norway, 7 miles east-north-east of Oberon. A. 06/178; M.M. 18/162; R. 18/51. *Bismuth.*

Wiseman's Creek, tributary of Campbell's River, parish of Jocelyn, &c., north-west of Oberon.

C.S.W. 77/205; J.E.C. 99/173; M.R. No. 6, 08/139, 147, 148, 160, 163, (Larry's Hill), 169, 177; Mines and Minl. Stat. 75/92; R. 76/78, 77/114, 78/97, 85/61, 89/134, 99/67, 04/46, 05/45, 07/52, 08/47, 09/47, 10/47, 11/52, 12/48, 13/52, 14/53, 84, 15/49, 16/48, 17/41, 18/39. *Copper.*

R. 85/47. *Silver.*

Essington, parishes of Adderley and Baring.

C.S.W. 77/201, plan; J.E.C. M.R. No. 6, 08/135, 141, 143, 160, 166; R. 01/54, 05/45, 07/52, 08/47, 14/53. *Copper.*

Parish of Irene. J.E.C. M.R. No. 6, 03/143. *Copper.*

Briar Park, parish of Irene, 16 miles west-south-west of Oberon, south-east of Rockley.

R. 94/60; Bore, 16/71; M.R. No. 25, 19/346. *Limestone, Marble.*

C.S.W. 77/201, 205. *Gems, Asbestos.*

Digitized by Google

Mount Stromlo, parish of Baring, west of Oberon, and parish of Duckmaloi, south-east of Oberon.
J.E.C. M.R. No. 15, 12/55, 56, 61, 63, 85; R. 09/59.
Wolfram, Sheelite.

Parish of Bolton, 8 miles north-west of Oberon. C.S.W. 77/201. *Gold.*
E.C.A. M.R. No. 24, 16/60, 133.
Titania, 4 miles from Oberon. Assay, 06/179. *Cobalt.*
Vicinity. Assay, 07/182. *Manganese.*
M.P. 82/100. *Antimony.*

Campbell's River, Walbrook, parish of Swatchfield, 16 miles south-south-west of Oberon. Briar Park and Swallows Nest, parish of Irene [*see* Rockley), 15 miles south-west of Oberon. Wiseman's Creek, parish of Jocelyn, 7 miles north-west of Oberon, county of Westmoreland, parishes of Walbrook and Mount Lawson, county of Georgiana. M.R. No. 25, 19/346, 348; R. 94/60. *Limestone.*

Parish of Bolton, 6 miles south of Yetholme. E.C.A. 17/165.
Molybdenite.

OBX CREEK. [*See* Chambigne.]

O'CONNELL. Breakfast Creek, parish of Jocelyn, county of Westmoreland, 4 miles south of O'Connell, 10 miles north-west of Oberon, 2 miles north of Wiseman's Creek. M.P. 82/108; R. 75/65, 97/29, 99/23, 05/11, 14/17, 84, 15/15. *Gold.*

Fish River, O'Connell Plains, parish of Langdale. Dredge 01/35, 02/31, 03/30. *Gold.*

OMADALE BROOK. [*See* Moonan Flat.]

ONE TREE HILL. [*See* Peelwood.]

OORUNDUNBY. [*See* Walcha.]

OPHIR. Summer Hill or Frederick's Valley and Lewis Ponds Creeks parish of Lewis, county of Wellington, parishes of Worcester and Lennox, county of Bathurst, 10 miles north-east of Orange. Parliamentary Papers G.F. 1873–4; E.F.P. M.R. p. 4; M.P. 82/23; Rec. VI, pt. 4, 00/215, 224, 227, 242; R. 75/23, 82/36, 84/53, 113, 11/16, 15/15.
Gold.

J.E.C. M.R. No. 7, 13/17, 18; E.F.P. M.R. p. 275; J.E.C. M.R. No. 6, 08/, p. 161. [*See* Lewis Ponds.] *Copper, Silver.*
T.W.E.D. 91/229. *Gems, Beryl.*
District. M.P. 82/85. *Platinum.*
E.F.P. M.R. p. 275. *Mercury.*
Springfield Estate, east of Orange. R. 06/46. *Copper.*

ORANGE. Fredrick's Valley and Stony Creeks, Wentworth Mines, Lucknow, Bletchington Estate, parish of Huntley, county of Bathurst, 3 miles south-east of Orange. C.S.W. 81/131, 134, 84/53; E.F.P. M.R. p. 43; Rec. VII, pt. 1, 00/1; J.E.C. Rec. I, pt. 2, 89/42; Rec. VI, pt. 4, 00/192, 214, 222, 234; R. 78/70, 80/86, 93/20, 62, 94/21, 95/18, 96/26, 98/29 plan, 99/24, 00/14, 02/14, 95, 04/11; R. 05/11, 06/16, 97, 07/18, 08/15, 09/15, 11/16, 12/15, 13/16, 14/17, 15/15, 17/13, 18/12. *Gold.*

Summer Hill or Fredericks Valley Creek. [*See* Ophir.] E.F.P. M.R. p. 4; M.P. 82/23; Rec. VI, pt. 4, 00/207, 220, 227, 242; R. 94/21.2
Gold.

Digitized by Google

Eldorado, Mount Bulga, Palmer's, Bulga, Trappitt's, and Bald Hills, parish of Clinton, county of Bathurst, 5 to 9 miles east to east-north-east of Orange. R. 87/51, 05/11, 06/16, 07/18, 08/16, 10/16. *Gold.*

J.E.C. M.R. No. 6, 08/157; R. 01/54, 82, 03/47, 04/46, 08/47, 09/47, 10/47, 101, 11/52. *Copper.*

J.E.C. M.R. No. 6, 08/158; R. 97/30. *Limestone.*

Rosedale Mountains, Lindsay and Shorter, parish of March, county of Wellington, north of Orange. E.F.P. 99/166; R. 00/15, 01/13, 02/14, 03/12, 04/11, 12, 05/11, 06/16. *Gold, Silver* (trace).

J.E.C. M.R. No. 6, 08/158, 160, 166; R. 00/55, 18/39. *Copper.*

Wellwood paddock, near Lucknow. J.E.C. M.R. No. 6, 08/175; J.B.J. 16/78; R. 16/15, 17/75; Assay 04/151. *Gold, Copper, Lead, Zinc.*

Bob's Mount, Emu Swamp, parish of Worcester, county of Bathurst, near Lewis Ponds, Springfield. J.E.C. M.R. No. 6, 08/114; R. 05/45, 06/46. *Copper, Silver.*

District. J.E.C. M.R. No. 15, 12/88. *Cupro, Sheelite.*

J.E.C. M.R. No. 16, 12/39; E.F.P. M.R. p. 246; Assay 16/219. *Antimony.*

14 miles south-west of Orange. M.P. 82/118. *Manganese.*

Rose Hill Estate, Ophir-road, 4 miles from Orange. J.B.J. Mem. G. 2, 01/139. *Iron.*

Near Orange. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 269. *Bismuth.*

Parish of Anson, county of Bathurst, 6 miles east of Orange. E.C.A. M.R. No. 24, 16/134. *Molybdenite* (traces).

Parish of Bowan, county of Ashburnham, 11 miles from Borenore. M.M 17/167. *Tripolite.*

Spring, Bourimbla, and Paling Yard Creeks, parishes of Boree Carbonne, Barton, and Bowen, county of Ashburnham, 14 to 15 miles north to south-west of Orange. [*See* Cudal and Molong.] *Limestone.*

Flyer's and Cadia Creeks, parishes of Waldegrave and Beneree, Bulga Mount, parish of Clinton, parish of Anson, Upper Lewis Ponds, parish of Worcester, county of Bathurst, 4 miles east to 11 miles south of Orange. M.R. No. 25, 19/173, 175. *Limestone.*

ORANGE PLAINS. [*See* Tottenham.]

ORUNBIMBIE (or Orundundy). [*See* Coal Index.]

OTTERY LODES. [*See* Vegetable Creek.]

OTTLEY'S CREEK. [*See* Coal Index.]

OURANIE. [*See* Jingellic.]

OVERFLOW. [*See* Bobadah.]

OXLEY MOUNT. County of Cowper, 20 miles south-east of Bourke. R. 04/53. *Bismuth in Ironstone.*

PACKSADDLE. [*See* Koorningherry.]

PADDY LACKY. [*See* Sunny Corner.]

PADDY'S FLAT. [*See* Drake and Peak Hill.]

PADDY'S CREEK. [*See* Bulladelah.]

PADDY'S GULLY AND PADDY'S LAND RANGE. [*See* Kookarabooka.]

Digitized by Google

PADDY'S PEAK. Parish of Wangaderry, county of Camden, 14 miles north-west of Mittagong. R. 06/46, 07/46. *Silver.*

PADDY'S RIVER. [*See* Bingara, Congwarra, and Wingello.]
Shoalhaven. E.F.P. M.R. p. 429; G.W.C. and W.S.D., Rec. V, pt. 3, 97/147. *Tripolite.*

PADDY'S SUGARLOAF. [*See* Vegetable Creek.]

PAGE RIVER. County of Brisbane, east of Murrurundi. M.P. 82/86. *Silver.*

PALING YARD CREEK. [*See* Burraga, Cudal, and Orange.]

PALING YARDS. [*See* Barraba.]

PALMER'S BULGA. [*See* Mullion and Orange.]

PALMER'S OAKY. Parishes of Dulabree and Turon, county of Roxburgh, between Sofala and Sunny Corner. R. 95/19, 04/19, 05/11, 14/17. *Gold, Silver.*
Parr's Range, near head of Palmer's Oaky. *Silver.*
Rowdy Bobs Creek. R. 95/19. *Gold.*
L.F.H. Rec. VIII, pt. 4, 09/327; M.R. No. 25, 19/319. *Limestone.*

PAMBULA. Parishes of Gnupa, Panbula, and Yowaka, county of Auckland. W.A. 90/263; J.E.C. 96/107; E.F.P. M.R. p. 63; Rec. VI, pt. 4, 00/199, 237; R. 91/94, 92,19, 93/22, 94/28, 95/25, 96/33, 98/44, 99/37, 00/20, 01/20, 02/26, 03/24, R. 04/25; 05/22, 06/23, 07/80, 09/22, 10/23, 11/26, 12/23, 79, 13/25, 14/27, 84, 15/24, 83; R. 16/22, 80. *Gold.*
Pipe Clay Creek, 3 miles south of Pambula. R. 07/25, 08/22, 11/26, 15/24. *Gold.*
New Station Creek, parish of Yuglamah, 19 miles west of Pambula, 5 miles north-west of Wyndham. J.E.C. 94/124. *Gold.*
Burragate, parish of Burragate, 5 miles south of Wyndham, 15 miles south-west of Pambula, Little Jingera, 10 miles from Wyndham. R. 97/42, 98/45, 01/20, 09/23, 10/23. *Gold.*
Letts Mount, south-west of Burragate, parish of Pericoe. R. 89/86. *Silver.*
Jingera, Whipstick, Mount Metallic, and Pheasant's Nest Mines, Wyndham, parish of Wyndham, 10 miles west-south-west of Pambula and parish of Yuglamah, west of Wyndham. J.A.W. M.R. No. 4, 1898; J.E.C. 94/124; E.F.P. M.R. p. 261, 305; E.C.A. M.R. No. 24, 16/10, 31, 134, 150, 166; Rec. VI, pt. 4, 00/199, 214; R. 91/94, 92/39, 95/25, 97/42, 98/45; 74, 00/64, 03/24, 54, 05/52, 06/23, 57, 08/57, 09/23, 57, 92, 10/56, 11/62, 12/59, 60, 13/63, 64, 14/64, 65, 85, 15/59, 83, 16/58, 59, 17/52, 18/51; Assay, 02/132. *Gold, Silver, Bismuth, Molybdenite.*
Parish of Cobra. Assay 06/181. *Platinum.*
Wog Wog Creek, Lett's Mountain, parish of Pericoi, 6 miles south-west of Burragate. R. 89/86. *Silver.*
Coast, parish of Bournda, 8 miles north of Pambula, and at 4 miles from Pambula. L.F.H. 16/209; R. 06/60, 179, 17/56, 77; Assay 06/179. *Lignite, Kaolin.*
6 miles north-east of Pambula. A. 07/80. *Iron.*
Merimbula, parish of Bournda. L.F.H. 10/180. *Slate.*
Wyndham. Assay 06/178, 12/195, 14/214. *Barytes.*
M.P. 82/122. *Plumbago.*

Digitized by Google

PANKALLY CREEK. [*See* Noorooma.]

PANUARA RIVULET. Boundary between counties of Ashburnham and Bathurst, south of Orange. R. 77/81. *Gold.*

PAP'S CREEK. Parish of Coonbaralba, county of Farnell. *Silver, Lead.*

PARA CREEK. [*See* Purnamoota.]

PARADISE CREEK. [*See* Niangala and Vegetable Creek.]

PARKES. Parish of Parkes, Currajong, &c., county of Ashburnham; Billabong or Goobang Creek, parishes of Parkes and Martin, south of Parkes; Parliamentary Papers, G.F. 1873–4. E.C.A. 09/182; M.R. No. 13, 1910; Rec. VI, pt. 4, 1900; Mines and Minl. Statistics, 75/52; R. 75/32, 37, 76/49, 81, 77/79, 88, 78/71, 79/88, 93/63, 94/24, 95/20, 01/22, 02/18, 03/15, 04/15, 05/18, 06/12, 07/14, 08/12, 09/11, 10/12, 11/12, 12/11, 13/12, 14/12, 15/12, 17/11. *Gold.*

Scrubby Plains. C.S.W. 85/127. *Gold.*

Parish of Milpose, 16 miles north-west of Parkes. R. 14/12. *Gold.*

Goobang Station, parish of Currajong, &c., 2 to 5 miles north-west of Parkes. Goonumble Hill, parish of Goonumbla, county of Ashburnham, 12 miles north-west of Parkes, parish of Limestone, county of Kennedy, 13 miles north of Parkes. Currumbla Station, 12 miles west. J.E.C. M.R. No. 6, 08/280; R. 79/88, 82,/54, 83/65. *Copper, Gold.*

Tichborne, parish of Martin, county of Ashburnham, 8 miles south-west of Parkes. M.M. 18/161; R. 06/60, 07/66, 08/61, 09/60, 10/59, 15/12; Assay, 02/130. *Kaolin.*

Assay 04/152, 07/181. *Manganese.*

Limestone Plains, parishes of Goonumbla and Currajong, Crooked Creek, parish of Martin, from 4 miles north-west to 5 miles south-west of Parkes; parish of Limestone, 11 miles north-north-west. [*See* Alectown.] M.R. No. 25, 19/167, 168, 169, 259; M.P. 82/172; R. 76/51, 07/181, 15/57. *Marble, Limestone.*

Billabong or Goobang Creek, Parish of Nelungalong, 2 to 5 miles south-east of Gunningbland, 13 miles south-west of Parkes. *Limestone.*

7 miles north-west of Parkes; Assay 16/220. *Magnetic Iron.*

PARNANGA. [*See* White Cliffs.]

PARNASSUS MOUNT. [*See* Gundagai.]

PAROOK. County of Irrara. *Gypsum.*

PATERSON RIVER. Martin's Creek, parish of Barford, county of Durham, 3 miles north of Paterson. L.F.H. 15/187. *Road Metal.*

PAUL'S CREEK. [*See* Lionsville.]

PAUPONG (or Popong.) [*See* Dalgety.]

PEAK, SOUTH. [*See* Gilgunnia.]

PEAK, THE. [*See* Nuntherungie and Cobar.]

PEAKS, THE. [*See* Yerranderie.]

Digitized by Google

PEAK HILL. Paddy's Flat, &c., parish of Mingelo, county of Narromine. T.W.E.D. 89/213, 90/231; G.A.S. 89/235; W.A. 90/261; R. 89/62, 95/19, 98/32, 99/26, 00/16, 04/20, 05/15, 06/18, 07/20, 08/18, 09/18, 112, 10/19, 11/20, 12/18, 81, 13/20, 88, 14/21, 86, 15/19, 16/18, 17/15, 18/15, 77. *Gold.*

R. 16/48. *Copper.*

Peak Hill Mine. J.E.C. M.R. No.6, 08/299; R. 00/63. *Copper, Gold.*

Myall, parish of Bulgandramine, 9 miles north of Peak Hill. Rec. VI, pt. 4, 00/250; R. 98/32, 99/26, 00/17, 02/21, 03/19, 04/20, 05/15, 07/20, 08/18, 09/18, 13/20. *Gold.*

Tomingley, parish of Gundong, 12 miles north of Peak Hill. C.S.W. 85/128; R. 83/122, 85/56, 95/19, 99/26, 00/17, 04/20, 05/15, 07/21, 08/18, 09/18, 10/19, 11/20, 14/21. *Gold.*

Harvey Ranges and 9 miles north of Peak Hill. Assay 06/180, 16/220; R. 00/63. *Manganese.*

Parish of Mingelo, county of Narromine, 3½ miles south-east of Peak Hill, 1 mile north-west of Mingelo. M.R. No. 25, 19/297. *Limestone.*

Mingelo, parish of Burrell, county of Kennedy, 5 miles south-east of Peak Hill. R. 02/22; M.R. No. 25, 19/258. *Gold, Limestone.*

PEARCE'S CREEK. [*See* Katoomba.]

PEE DEE. [*See* Macleay River.]

PEEL. [*See* Bathurst.]

PEEL RIVER. R. VI, pt. 4, 00/199, 227. [*See* Nundle.]

PEELWOOD. [*See* Tuena.]

PEMBROKE. [*See* Trunkey.]

PEISLEY'S CREEK. [*See* Mount McDonald.]

PENNANT HILLS. County of Cumberland. C.S.W. 79/218. *Road Metal.*

PEPPER'S CREEK. [*See* Rockley.]

PETER'S GRASS and Yankee Creek, county of Rous, north-west of Mullamuddy, north of Lismore. C.S.W. 89/203; R. 89/131. *Gold.*

PHEASANT CREEK. Parish of Moogem, county of Clive, 26 miles north-east of Deepwater, 12 miles north-north-east of Glen Elgin. Parliamentary Papers by Norman Taylor, 1884, p. 20; J.E.C. M.R. No. 14, 11/294; E.F.P. M.R. p. 141; Rec. VI, pt. 4, 00/319; R. 83/91; Dredge 18/19. *Tin.*

E.C.A. M.R. No. 24, 16/89. [*See* Glen Elgin.] *Molybdenite.*

E.F.P. M.R. p. 269–302; R. 80/60. *Bismuth, Tungsten.*

Dredge 17/22. *Tin.*

PHEASANT'S NEST. [*See* Pambula.]

PHIL'S CREEK. [*See* Harden.]

PIALLAMORE. [*See* Tamworth.]

PIAMBONG. South-west of Gulgong. R. 98/31, 00/16. *Gold.*

PICTON. [*See* Coal Index.] Bargo, parish of Bargo, county of Camden, 7 miles south of Picton; Oak's Hermitage and Craigend Estates, 6 to 8 miles north-west of Picton. C.S.W. 91/212; J.B.J. Mem. G. 2, 01/54; E.F.P. M.R. p. 200; Iron ore deposits of N.S.W., 1910. *Iron.*

E.F.P. M.R. p. 450: Rec. VI, pt. 4, 00/311. *Mineral Spring.*

Douglas Creek, Wollondilly River, Nattai River, 10 miles west, 18 miles west-south-west and 20 miles south-west of Picton, parishes of Killawarrah and Wanganderry. M.R. No. 25, 19/204. *Limestone.*

Digitized by Google

PIEDMONT. [*See* Upper Bingara.]

PIDDINGTON MOUNT. Near Mount Victoria, parish of Hartley, county of Cook; J.F.C. Mem. G. 6, 08/238. *Pottery Clay.*

PIGEON HOUSE MOUNTAIN. Parish of Croobyar, county of St. Vincent, 12 miles west of Ulladulla, 5 miles south-east of the Mount. *Gold.*

PIGNA BARNEY RIVER. [*See* Macqueen.] Parish of Tomalla, county of Hawes, 22 miles south-south-west of Nowendoc; Assay 03/131, 07/177. *Chromite.*

PIKE'S REEF. [*See* Junee.]

PILOT MOUNTAIN. Snowy Range, parish of Beurina, county of Wallace; J.E.C. 04/140; M.R. No. 14, 11/282. *Tin.*

PILOT CREEK. [*See* Indi River.]

PINE CREEK. [*See* Warialda.]

PINE RIDGE. [*See* Dunedoo and Trunkey.]

PINNACLES. [*See* Broken Hill and Forbes District.] A. 92/52. *Rubbly Limestone.*

PIPECLAY. [*See* Delegate, Mudgee, and Pambula.] Port Stephens. A. 16/220. *Iron.*

PIPER'S CREEK. [*See* Kempsey.] Snowy River, parish of Guthega, county of Wallace, 11 miles north-east of Mount Kosciusko. J.B.J. 96/138. *Gold.*

PIPER'S FLAT. [*See* Wallerawang.]

PLANT CREEK. [*See* Vegetable Creek.]

PLATINA. [*See* Fifield.]

PLEASANT, MOUNT. [*See* Nundle and Noorooma.]

PLEASANT, MOUNT, CREEK. [*See* Holbrook.]

PLUMBAGO CREEK. [*See* Drake.]

POKOLBIN. Parish of Pokolbin, county of Northumberland, 18 miles south-west of Maitland. R. 07/55. *Copper (doubtful).*

Gap Road. M.R. No. 25, 19/299. *Concretionary Limestone.*

PONDS CREEK. [*See* Tingha.]

PONTO. [*See* Kooningberry and Wellington.]

POOLAMACCA. [*See* Torrowangee.]

POOLE, MOUNT. [*See* Dalmorton and Milparinka.]

POONCARRIE or Pooncaira. Darling River, county of Perry. R. 95/31. *Ironstone, Gold, Silver (trace).*

POPONG. [*See* Dalgety.]

PORTLAND. Jews Creek, parishes of Cullen Bullen and Ben Bullen, county of Roxburgh. Rec. V.I, pt. 4, 00/214. *Gold.*

J.E.C. Mem. G. 6, 08/234. *Iron.*

Portland, parish of Cullen Bullen, 6 miles north-west of Wallerawang. J.E.C. Mem. G. 6, 08/242, 243, 247; M.R. No. 25, 19/98, 318; R. 00/63, 01/63, 02/55, 05/51, 06/55, 07/61, 11/61, 12/57, 13/61, 14/62, 15/57, 17/50; parish of Falnash, 4 miles south-west of Portland. M.R. No. 25, 19/329. *Limestone.*

PORT HACKING. [*See* Coal Index.] M.P. 82/106. *Iron.*

PORT MACQUARIE. [*See* Hastings River and Macquarie.]

Digitized by Google

PORT STEPHENS. Ironstone Mountain, parish of Karuah, county of Gloucester, and between Karuah and the Williams River. T.W.E.D. 89/217, 91/240; J.B.J. 96/135, 98/169; Mem. G. 2, 01/71, &c.; E.F.P. M.R. p. 211; Iron Ore Deposits of N.S.W. 1910; Assay 16/220. *Iron.*

[*See* Clarence Town.] J.B.J. Mem. G. 2, 01/66; M.R. No. 25, 19/237. *Limestone.*

Pipe Clay Creek, Swan Bay. R. 06/63. *Fire Clay.*

Shores of Port Stephens. M.M. 17/168. *Road Metal.*

POSSUM POWER. [*See* Temora.]

POSTMAN'S CREEK. [*See* Bora Creek.]

POVERTY POINT. [*See* Timbarra.]

PRETTY GULLY. [*See* Drake.]

PROSPECT. County of Cumberland, 5 miles from Fairfield. C.S.W. 79/218. *Road Metal.*

PUCKA PUCKA. [*See* Gordonbrook and Lionsville.]

PUDDLEDOCK. [*See* Armidale.]

PUDMAN'S CREEK. [*See* Boorowa.]

PULGANBAR. [*See* Gordonbrook.]

PULLETOP CREEK. Bourke's Creek, Mount Clifton, Carter's Hill, Marbling Springs, &c., parishes of Burrandana, Westby, and Pulletop, county of Mitchell, 16 to 20 miles north of Holbrook. J.E.C.94/113; M.R. No. 14, 11/270, 271; E.F.P. M.R. p. 147, 296, 302; R. 99/72, 06/52, 11/58. *Tin.*

J.E.C. 97/171; M.R. No. 15, 12/50, &c.; R. 06/59, 10/57, 18/60. *Wolfram, Cassiterite.*

Mangoplah, parish of Burrandana, north-west of Pulletop. R. 98/39, 14/16, 15/15, 16/15. *Gold.*

PULLEY'S HILL or Ulmurrah. [*See* Hill End.]

PUNKALLY. [*See* Noorooma.]

PURGATORY. [*See* Cangai, Delegate, Bowraville, and Copmanhurst.]

PURNAMOOTA. 20 miles north of Broken Hill. [*See* Cartwright's Creek.]

Granite Springs, parish of Waukeroo, county of Yancowinna, east of Purnamoota. J.E.C. 97/171; M.R. No. 15, 12/58, 76; E.F.P. M.R. p. 303. *Tungsten.*

C.S.W. 87/138, 143; E.F.P. 01/159; J.E.C. M.R. No. 14, 11/247, 253, 257. *Tin.*

Parish of Mundi Mundi, west of Purnamoota. J.B.J. Mem. G. 5, 94/133. *Gold.*

Mount Robe and Yangalla, north-west of Purnamoota. R. 13/97, 14/95. *Gold.*

Appolyon Valley, parish of Stephen, between Purnamoota and Umberumberka, Para Creek, &c., parishes of Robe, Lewis, &c., 7 miles north-west of Parnamoota. C.S.W. Leg. Ass. N.S.W. 1076A, 1883–4; C.S.W. 87/143; J.B.J. G. 5, 94/118, 133; J.E.C. M.R. No. 6, 08/93, 98, 103; Rec. Vol. I, 89/56; R. 12/91, 13/97, 03/41. *Copper, Gold, Silver.*

Parish of Waukeroo, county of Yancowinna. J.E.C. M.R. No. 6, 08/94. *Copper.*

Waukeroo paddock, parish of Torrowangee, county of Farnell, 10 miles north of Purnamoota. J.E.C. M.R. No. 6, 08/102. *Copper, Calcite.*

Digitized by Google

PURNANGA. Parish of Purnanga, county of Fitzgerald, 40 miles north-east of White Cliffs. R. 97/66. *Opals.*

PURSURS CREEK. [*See* Rylstone.]

PYES CREEK. [*See* Vegetable Creek.]

PYRAMUL and Cow Flat. Parishes of Boiga and Tunnabidgee, county of Wellington, 9 miles south-east of Windeyer. R. 75/27; Rec. VI, pt. 4, 00/224. *Gold.*

PYRAMUL CREEK. Extends from 12 miles south-west of Cudgegong to the Macquarie River, 14 miles south-east of Stuart Town. J.E.C. M.R. No. 16, 12/3, 43; M.P. 82/99 *Antimony.*

E.F.P. M.R. p. 385; D.C.McL. Diamonds in N.S.W. 99/5; M.P. 82/121. *Diamonds.*

PYRMONT. C.S.W. Letter-book 1889, p. 19. *Natural Gas.*

QUACKANACCA. [*See* Nundle.]

QUAMBURRA BAY or Quinburra. [*See* Bog.]

QUART POT CREEK. [*See* Dalmorton and Noorooma]. Parish of Jesse, County of Roxburgh. *Gold.*

Parish of Mayo, county of Hardinge. *Tin.*

QUARTZ RIDGE. [*See* Sofala.]

QUARTZVILLE. [*See* Tumbarumba.]

QUEANBEYAN. Molonglo River, parish of Queanbeyan, county of Murray. J.B.J. 93/126; R. 95/24, 97/39. *Gold.*

Macs Reef. R. 87/82. *Gold.*

J.E.C. M.R. No. 15, 11/85. *Sheelite.*

London Bridge, Molonglo River, parish of Burra, 11 miles south of Queanbeyan. J.E.C. M.R. No. 6, 08/391; Rec. VI, pt. 4, 00/199; R. 07/81. *Copper, Silver, Lead.*

London Bridge, parishes of Burra and Urialla. M.R. No. 25, 19/296. Parish of Gigerline, Murrumbidgee River, 10 miles south-west of Queanbeyan; parish of Goorooyarroo, 11 miles north-north-west; Mount Majura, parish of Pialligo, 8 miles north-north-west; parish of Weetangera. M.R. No. 25, 19/288, 289, 293, 297.

Parish of Carwoola, east of Queanbeyan, Uriara 16 miles from Queanbeyan and west near Murrumbidgee River. J.E.C. M.R. No. 6, 08/365, 374, 391; R. 98/96, 06/48. *Copper, Silver.*

[*See* Congwarra.] *Iron.*

Parish of Googong, 3 miles south of Queanbeyan. M.R. No. 25, 19/288. *Limestone.*

Jerrabomberra Creek, near junction with Molonglo River, parish of Queanbeyan, between Queanbeyan and Canberra. M.R. No. 25, 19/9, 293. *Limestone.*

Tharwa, 14 miles south-west of Queanbeyan, and at 20 miles south-west, in parishes of Cuppacumbalong and Yarara, county of Cowley. M.R. No. 25, 19/211, 213. *Limestone.*

Limestone Creek. [*See* Captain's Flat.]

QUEDONG or Quidong. [*See* Delegate and Bombala.]

QUEEN BEE. [*See* Cobar.]

QUEEN CHARLOTTE'S VALE CREEK. [*See* Rockley.]

Digitized by Google

QUEEN'S PINCH. Parishes of Broombee and Warratra, county of Wellington *Gold.*

QUIDONG. [*See* Delegate.]

QUIGLEY'S HILL. [*See* Blayney.]

QUINBURRA. [*See* Bog.]

QUIRINDI. Parish of Lodar, county of Buckland, 11 miles east of Quirindi. *Pitchstone overlying Keresone Shale.*

M.P. 82/103. *Tin.*

Marble Hall, parish of Wallabadah, county of Buckland, 6 miles east-north-east of Quirindi; parish of Quirindi, 3 miles east. M.R. No. 25, 19/200. *Limestone.*

RAGAN MOUNT. [*See* Lewis Ponds.]

RAINBOW. [*See* Copeland.]

RAMPSBECK. [*See* Aberfoyle.]

RANDWICK. County of Cumberland. M.M. 12/192. *Sandstone.*

RANGER'S VALLEY. Beardy River. [*See* Vegetable Creek.]

RANKIN'S SPRINGS. Parishes of Conapaira and Conapaira East, county of Cooper, 35 miles north of Narrandera, 10 miles south of Rankin's Springs, 28 miles west of Yalgogrin. J.B.J. 13/83; R. 13/58, 14/58, 16/53, 17/47. *Tin.*

R. 17/88. *Wolfram.*

RATHLUBA. [*See* Coal Index.]

RATS CASTLE. [*See* Mudgee.]

RATS HEAD. [*See* Noorooma.]

RAVENSWORTH. Parishes of Vane and Ravensworth, county of Durham, 12 miles north-west of Singleton. C.S.W. 84/151; J.B.J. Mem. G. 2, 01/111. *Limonite.*

RAVINE or Lobb's Hole. Tumut and Yarrangobilly Rivers, parish of Pinbeyan, county of Buccleuch, and parish of Selwyn, county of Selwyn, 8 to 12 miles north of Kiandra. J.E.C. M.R. No. 6, 08, 379, 381, 384, 396; E.C.A. 01/169; R. 80/133, 91/104, 99/68, 00/56, 02/50, 03/48, 04/47, 05/45, 06/48, 07/53, 08/48, 09/48, 10/47, 11/53, 12/49, 13/52, 14/54, 15/49, 16/49, 82, 17/42, 18/39; Bore 18/74; J.B.J. 18/75. *Copper, with Silver and Gold* (trace.)

District. R. 13/15. *Gold.*

J.E.C. Bulletin No. 7 of the territory of Papua, 1913, p. 78. J.B.J. 16/78; R. 11/197, 16/82; M.R. No. 25, 19/198, 326. *Natural Gas, Limestone.*

RAYDON VALE. [*See* Copeland.]

RAZORBACK. [*See* Broken Hill, Sofala, and Yambulla.]

REA MOUNT (or Rae.) [*See* Dalmorton.]

REDBANK. [*See* Wangat and Wattle Flat.]

REDLAND. [*See* Corowa.]

REDHEAD. [*See* Coal Index.]

RED HILL. [*See* Blayney, Bulladelah, Gulgong, Inverell, Major's Creek, Tingha, Tumut, Yass, &c.]

RED RANGE. [*See* Kingsgate.]

RED ROCK. [*See* Drake.]

Digitized by Google

REEDY CREEK. [*See* Bumberry, Bungendore, Gulgong, and Molong.]

REEDY FLAT. [*See* Batlow.]

REEFTON. [*See* Barmedman.]

REID'S FLAT. [*See* Boorowa.]

REILLY'S CREEK. [*See* Sofala.]

REMARKABLE MOUNT. [*See* Dalmorton.]

REMINGTON. [*See* Yass.]

RENO. [*See* Gundagai.]

RESTDOWN. [*See* Yalgogrin.] Parish of Restdown, county of Mouramba, 15 miles south-south-west of Canbelego, 20 miles north-north-west of Nymagee. J.B.J. 95/175; R. 94/32, 95/30, 84, 97/50, 93. *Gold.*

3 miles south of Copper Mine, parish of Bulga, county of Flinders. *Limestone.*

Parish of Bulga, county of Flinders, 15 miles south-south-east of Canbelego. J.E.C. M.R. No. 6, 08/196; E.C.A. M.R. No. 18, 13/107. *Copper, Silver.*

RICHMOND RIVER. [*See* Beach.] Counties of Richmond and Rous. E.F.P. 80/245; J.E.C. 97/169; J.C.H.M. Jour. Roy. Soc. of N.S.W., XXVI, 1892, p. 368; R. 89/131. *Gold, Platinum.*

RILEY'S CREEK. [*See* Wattle Flat.]

RINGWOOD. [*See* Coal Index.]

RIVERTREE. Cullen's Creek, Clarence River, parish of Clarence, county of Buller, 15 miles north-east of Wilson's Downfall. J.E.C. M.R. No. 6, 08/306; R. 97/61, 16/45, 18/37. *Copper, Silver.*

Wongabah, Cullen's Creek, &c. C.S.W. 89/201; E.F.P. M.R. p. 114; E.C.A. 00/192; R. 89/134, 95/55, 98/68, 03/44, 04/151, 05/41, 06/43, 07/47, 11/48, 12/45, 13/22, 48, 14/50; A. 12/196.

Silver, Gold, with sulphides of Copper, Antimony, Iron, Lead, Zinc.

RIVERVIEW. [*See* Noorooma.]

RIX'S CREEK. [*See* Coal Index.]

Parish of Darlington, county of Durham, north-west of Singleton. C.S.W. 84/151; J.B.J. Mem. G2, 01/111. *Iron.*

ROBE, MOUNT. [*See* Purnamoota.]

ROBERTSON. [*See* Coal Index.] Parishes of Kangaloon and Yarrawai, county of Camden. R. 87/75. *Iron.*

ROBINSON'S HOLE. [*See* Coal Index; *See* Brogo River.]

ROCK FLAT CREEK. [*See* Cooma.]

ROCKLEY. Back Creek, Mountain Run, Pepper's Creek, Brownlea, &c., parishes of Arkell and Bringellet, county of Bathurst, 6 miles north-west of Rockley. J.B.J. 93/125; R. 84/55, 86/54, 87/111, 89/53, 92/39, 01/15, 05/12, 17/14. *Silver, Gold.*

Apsley, Belmore, Cow Flat, Sugarloaf, Mountain Run, &c., parish of Ponsonby, county of Bathurst, 7 miles north of Rockley, 10 miles south of George's Plains Railway Station. C.S.W. 77/201; J.E.C. 99/170; M.R. No. 6, 08/106, 109, &c.; R. 75/59, 60, 76/36, 74; 77/114, 201, 79/72, 81/37, 98/71, 99/71, 00/55, 01/54, 05/45, 06/46, 47, 07/52, 09/47, 11/52, 12/48, 13/52, 14/53, 15/48, 16/48. *Copper.*

Mount Morris, 2 miles east of Apsley Mine. J.E.C. M.R. No. 6, 08/148, 159; R. 99/67. *Copper, Gold, Silver.*

Black Mountain, parish of Arkell, county of Bathurst. J.E.C. M.R., No. 6, 08/110. *Copper.*

Digitized by Google

Caloola, or Queen Charlotte's Vale Creek, parish of Ponsonby, county of Bathurst, north-west of Rockley. M.P. 82/117; R. 75/59, 95/17, 00/14, 02/15, 05/12, 06/16, 07/18, 09/15, 10/16, 11/17, 13/17, 14/18. *Gold.*

Cow Flat and Ponsonby. R. 18/65. *Talc.*

Caloola Creek, Back Creek. Assay 06/180; R. 18/63. *Manganese.*

M.P. 87/43; R. 85/52. *Barytes.*

Davy's Creek, parish of Oakley, county of Bathurst, north-east of Rockley. R. 97/29. *Gold.*

Eagle Vale, 13 miles from Rockley. R. 94/21. *Gold.*

Summer Hill, parish of Rockley, county of Georgiana, 3 miles south of Rockley. C.S.W. 77/200; J.E.C. M.R. No. 6, 08/150, 171; E.F.P. M.R., p. 152; R. 01/54, 05/45, 15/15. *Copper.*

Burramagoo, 5 miles south of Rockley. R. 83/32, 126, 93/19. *Copper.*

M.P. 82/107. *Iron.*

Parish of Rockley, county of Georgiana. J.E.C. M.R. No. 15, 12/88. *Cupro-Scheelite.*

R. 94/21, 97/29. *Asbestos.*

C.S.W. 91/215; E.F.P. M.R. p. 238; R. 84/55, 86/54, 91/67, 95/67, 06/60, 07/66, 181. *Manganese.*

R. 77/58, 114, 05/51. *Iron.*

Mount David, or Mount Maud, parish of Mount Lawson, county of Georgiana, 7 to 11 miles south-south-east of Rockley. J.E.C. 94/116; E.F.P. 96/98; R. 95/17, 96/26, 97/28, 98/28, 99/22, 00/14, 01/15, 02/15, 03/12, 04/12, 05/12, 06/16, 07/18, 08/16, 09/15, 10/16, 11/17, 12/16, 13/17, 14/18, 84, 15/16, 83, 16/16, 17/14, 18/12. *Gold.*

Lawson's Plains. R. 96/26. *Gold.*

Gilmandyke, includes Summer Hill and Mount Lawson, noted above.

Swallows' Nest, east of Campbell River, parishes of Irene and Swatchfield, county of Westmoreland, south-east of Rockley, 14 miles south-west of Oberon. C.S.W. 77/201; R. 03/12, 05/12. *Gold.*

Blossom Hill, Main Ridge, &c., parish of Irene, county of Westmoreland, south-east of Rockley, east of Campbell River. R. 81/39, 03/12, 06/16, 07/18, 66, 09/16, 14/84, 15/16. *Gold.*

Caloola or Queen Charlott's Vale Creek, parishes of Lowry and Ponsonby; Summer Hill Creek and Cow Flat, parish of Ponsonby, county of Bathurst, 5 to 8 miles north-west of Rockley. J.E.C. 92/146; Mem. G. 6, 08/233; L.F.H. 04/147; W. N. Benson, Proc. Linn. Soc. N.S.W., XXXII, 07/545; R. 06/60, 07/61, 66, 180, 08/56, 09/56, 60, 10/16, 59, 11/61, 66, 13/66, 15/57, 63, 16/63, 18/63; M.R. No. 25, 19/122, 123, 128, 180, 182. *Marble, Limestone.*

Pepper's Creek, parish of Arkell, parish of Bringellet, county of Bathurst. From Rockley to 4 miles north-west, Campbell River, parish of Rockley, county of Georgiana, from Rockley to 2 miles south-east. M.R. No. 25, 19/120, 173, 176, 234. *Limestone.*

Briar Park, parish of Irene, county of Westmoreland. R. 94/60. Bore 16/71; M.R. No. 25, 19/120, 346. *Limestone, Marble.*

ROCKVALE. [*See* Hillgrove.]

ROCKWELL. [*See* Broken Hill.]

ROCKY CREEK. [*See* Inverell and Vegetable Creek.]

Digitized by Google

ROCKY BRIDGE CREEK. [*See* Mount McDonald and Trunkey.]
ROCKY HALL. [*See* Bombala.]
ROCKY RIVER. [*See* Drake, Timbarra, Uralla, and Wunglebong.]
RODD'S CREEK. [*See* Carcoar.]
ROLAND'S CREEK. Parish of Nullum, county of Rous, 26 miles north of Lismore. *Gold.*
ROLLAND'S PLAINS. [*See* Gundle.]
ROOKERY. [*See* Cobar.]
ROOT HOG. [*See* Hillend.]
ROSEBROOK. [*See* Umaralla and Cooma.]
ROSEDALE. [*See* Orange.]
ROSEHILL. [*See* Geurie and Cullinga.]
ROSE VALLEY. [*See* Vegetable Creek.]
ROSEWOOD. [*See* Tumbarumba.]
ROSSITER MOUNT. [*See* Drake.]
ROTHERFIELD. [*See* Albury.]
ROUND HILL. Clear Creek, Tumut River, parish of Round Hill, county of Selwyn, 15 miles south of Kiandra. E.C.A. M.R. No. 10, 01/30. *Gold.*
ROUND MOUNT AND WATER HOLES. [*See* Kookarabooka.]
ROWDY BOB'S CREEK. [*See* Palmer's, Oaky.]
RUBY CREEK. [*See* Mount Werong and Wilson's Downfall.]
RUBY HILL. [*See* Bingara and Vegetable Creek.]
RUINED CASTLE. [*See* Coal Index.]
RUSSELL'S RANGE. [*See* Noorooma.]
RYE PARK. [*See* Boorowa.]
RYDAL. Mount Lambie, parish of Falnash, county of Cook, 3 miles north-west of Rydal. J.E.C. Mem. G. 6, 08/234; M.P. 82/105, 107; R. 83/36. *Iron.*
Honeysuckle Range, parish of Falnash, 5 miles north-west of Rydal. M.P. 82/83. *Silver.*
Parish of Thornshope, county of Roxburgh, 6 miles west of Rydal. E.C.A. M.R. No. 24, 16/60. *Molybdenite* (traces).
Brunt's Creek, parish of Falnash, county of Cook, 7 miles north-west of Rydal. J.E.C. Mem. G. 6, 08/241, 243. *Limestone.*
RYLSTONE. [*See* Cudgegong.] Parish of Tongbong, north of Cudgegong River, county of Phillip, 4 miles west of Rylstone. M.R. No. 25, 19/310. *Limestone.*
Pursur's Creek. R. 94/23. *Gold.*
Vicinity. J.E.C. 04/139. *Ornamental Stone* (*Nepheline Ægirine*).
15 miles north-west of Rylstone. Assay 03/140. *Copper* (*Bornite*) *with Silver.*
District. R. 18/162. *Barytes.*

SALLY'S FLAT. [*See* Hill End.]
SALVATION HILL. [*See* Gulgong.]
SAM'S MOUNT. Parish of Warne, county of Wellington, 12 miles south of Stuart Town. *Gold.*
SAM'S REEF. [*See* Cowra.]

Digitized by Google

SANDY CREEK. [*See* Abington, Bateman's Bay, Tingha, and Tumut.] Mount Wheoga, Sandy Creek Station, Weddin Range, parish of Wheoga, county of Gipps, 24 miles south of Forbes. R. 88/75, 99/28. *Gold.*

SANDY MOUNT. County of Clive, probably head of Mole River, south of Tenterfield. M.P. 82/103. *Tin.*

SAPLING POINT. [*See* Yass.]

SARA RIVER. [*See* Kookarabooka.]

SASSAFRAS. [*See* Ettrema.]

SAWPIT GULLY. [*See* Drake, Nerrigundah, Nundle, and Uralla.]

SCABBING FLAT. [*See* Trunkey.]

SCABBY ROCK. [*See* Coonabarabran.]

SCONE. Parish of Macqueen, county of Brisbane, 5 miles east of Scone. M.R. No. 25, 19/197. *Limestone* (*Travertine*).

Parish of Isis, 10 miles east of Wingen, parish of Waverley, 14 miles east of Blandford. R. 11/21. *Gold*, *Silver* (poor).

Near Scone. J.E.C. M.R. No. 7, 13/17; R. 95/14. *Mercury.*

SCOOP HOLE. [*See* Yalgogrin.]

SCOTT MOUNT. [*See* Dunedoo.]

SCRUB YARDS. [*See* Temora and Young.]

SCRUBBY PLAINS. [*See* Parkes.]

SCRUBBY RUSH. [*See* Mount McDonald and Tuena.] Parish of Rouse, county of Bligh, 16 miles north-west of Gulgong, between Mount McDonald and Woodstock. R. 17/75. *Gold.*

County of Clive. J.E.C. 97/169. *Tungsten.*

SEAHAM. [*See* Coal Index.] Williams River, parish of Seaham, county of Durham. J.B.J. 97/176. *Iron.*

SEAVIEW MOUNT. West of Hastings River, parish of Hastings, county of Hawes, 42 miles north-west of Port Macquarie. *Gold.*

SEBASTOPOL. [*See* Broken Hill.] Parishes of Trigalong and Walladilly, county of Bland and parish of Sebastopol, county of Clarendon, 9 miles south to 12 miles south-west of Temora. R. 85/69, 04/17, 10/13. *Gold.*

SERPENTINE RIVER. [*See* The Valley.]

SEVERN RIVER. North of the River. [*See* Vegetable Creek]. Counties of Arrawatta, Clive, and Gough. [*See* Deepwater and Torrington.] South of the river. [*See* Wellingrove.] Head of river. R. 77/109. *Bismuth.*

19 miles from Glen Innes. Dredge 18/20. *Tin.*

SEWELL'S CREEK. [*See* Oberon.]

SHANNON VALE. [*See* Glen Innes.]

SHARPENING STONE CREEK. [*See* Yass.]

SHARP'S CREEK. [*See* Adelong.]

SHAW'S CREEK. [*See* Goulburn.]

SHEBA MOUNT or Red Hill. [*See* Nundle.]

SHEEP STATION CREEK. [*See* Dalmorton, Delungra, and Kingsgate.) Parish of Turrawarra, county of Murchison, 20 miles north-east of Bingara. Papers Mines Misc. 99/15123. *Tin.*

SHELLHARBOUR. Parish of Terragong, county of Camden. J.E.C. 04/140; L.F.H. Mem. G. 7, 15/273; Assay 95/186. *Gold, Tin, Platinum, Copper, and Lead.*

SHELLMALLIER. [*See* Lionsville.]

Digitized by Google

SHELLY'S FLAT. [*See* Marulan.]
SHEPHERD'S TOWN. [*See* Adelong.]
SHERWOOD. [*See* Uralla.]
SHOALHAVEN RIVER. [*See* Oallen Crossing, Marulan, and Touga.] Counties of Argyle, Murray, and St. Vincent. J.B.J. 94/139, 141; Rec. IV, pt. 3, 95/126; Rec. VI, pt. 4, 00/195, 226; R 75/44, 80, 04/23, 14/25; Dredge 01/35, 04/28, 12/25. *Gold.*
SHOOTER'S HILL. Yarrabella, parish of Bulgarres, county of Westmoreland. Between Shooter's Hill and Ginkin. R. 14/84. *Gold.*
SHORTER MOUNT. [*See* Orange.]
SHUTTLETON. [*See* Nymagee.]
SIDMOUTH VALLEY, 21 miles north of Emmaville. *Tin.*
SILENT GROVE. [*See* Vegetable Creek.]
SILVERDALE. [*See* Yass.]
SILVERTON. [*See* Broken Hill.]
SINGLETON. [*See* Rix's Creek and Coal Index.]
SKELETON CREEK. [*See* Glen Innes.]
SLASHER'S FLAT. [*See* Mudgee.]
SLATY CREEK. [*See* Drake.]
SLATTERY'S CREEK. [*See* Forest Reefs.]
SLAUGHTER-HOUSE CREEK. [*See* Delegate.] Parish of Singapora, county of Burnett, 25 miles east of Moree, 19 miles south-west of Warialda. G.A.S. 95/160. *Gold* (poor).
SLAUGHTER-HOUSE RANGE. [*See* Warialda.]
SLIPPERY CREEK. [*See* Oberon.]
SMITH'S CREEK. [*See* Murwillumbah and Kempsey.]
SNODGRASS. Parish of Granville, county of Wellesley, 20 miles west of Delegate. E.F.P. 09/177; R. 09/53, 10/52. *Gold, Diamonds* (reported).
SNOWBALL. [*See* Gundagai.]
SNOWBALL CREEK and Little Snowball. Parish of Currambene, county of Dampier, head of Shoalhaven River, 30 miles south of Braidwood. R. 93/6, 95/24. *Gold,* (*Bismuth* reported).
SNOWY RIVER. [*See* Dalgety.] Counties of Wallace and Wellesley. Rec. VI pt. 4, 00/196, 199; Dredge 01/35, 02/31. *Gold.*
SOFALA. [*See* Wattle Flat and Turon River.] Whalan's Hill, &c., Turon River, parish of Sofala, county of Roxburgh. Parliamentary Paper Goldfields of N.S.W., 1873–4; J.B.J. 96/128; Rec. VI, pt. 4, 00/224; R. 75/69, 80/89, 95/19, 03/25, 05/23, 06/17, 09/17, 10/18, 11/19, 13/18, 14/19, 15/18, 16/17, 17/15, 18/14; Dredge 00/36, &c. *Gold.*
Spring Creek, 3 miles south-west of Sofala. R. 04/25, 07/19, 08/17. *Gold.*
J.E.C. M.R. No. 15, 12/85. *Sheelite.*
Reilly's Creek. R. 94/23. *Gold.*
Tobin's or Arthur's Oaky Creek, Hill Top, parishes of Dulabree and Sofala. R. 07/19, 08/17. *Gold.*
J.E.C. M.R. No. 6, 08/373. *Copper.*
Box Ridge, Quartz Ridge, Turondale, Turon River, parish of Waterbeach, west of Sofala. E.C.A. 03/134; J.A.W. 03/134; R. 75/28, 77/66, 90/135, 95/19, 02/27, 07/19. *Gold.*
Middle Creek, Jew's or Wallaby Creek, parish of Waterbeach. J.E.C. M.R. No. 6, 99/156; R. 89/61, 01/75. *Copper, Gold.*

Digitized by Google

Razorback, parish of Walkerton, 7 to 10 miles east to north-east of Sofala. C.S.W. 86/138; J.E.C. 02/124, 04/25; M.R. No. 16, 12/43; M.P. 82/100; R. 81/44, 84/59, 86/58, 87/56, 88/68, 00/17, 02/27. *Gold, Antimony.*

Crudine, parish of Crudine, county of Roxburgh, parish of Cunningham, county of Wellington. north of Sofala. R. 75/27, 94/5, 10/17. *Gold.*

C.S.W. 86/138; J.E.C. M.R. No. 16, 12/30; R. 80/220, 06/178. *Antimony.*

Mount Wiagdon, parish of Wiagdon, county of Roxburgh, 7 miles south of Sofala; parishes of Sofala and Waterbeach. M.R. No. 25, 19/322, 323, 325. *Limestone.*

SOLDIER'S CREEK. [*See* Canobolas.]

SOLFERINO. [*See* Lucasville.]

SOLITARY CREEK. [*See* Wattle Flat.]

SOLITARY MOUNT. [*See* Mount Hope.]

SOMERTON. Parish of Somerton, county of Parry, 5 miles south-south-west of Somerton, and parish of Bective, 8 miles south-east; parish of Moorowa, 6 miles south-west. M.R. No. 25, 19/299, 302, 304. *Limestone.*

Namoi River, parishes of Keepit and Namoi, county of Darling, 8 miles north-north-west of Somerton, Peel River, parish of Moorowara, county of Parry, and parish of Carrol, county of Buckland, 6 miles south-west of Somerton. M.R. No. 25, 19/220. *Limestone.*

SOUNDING ROCK. [*See* Tuena.]

SPA CREEK. [*See* Bungonia.]

SPICER'S CREEK. [*See* Coal Index.] Bald Hill, parish of Mitchell. R. 78/70. *Gold.*

Parishes of Elong Elong and Cobrauragay, county of Lincoln, 21 miles north-north-east of Wellington. M.R. No. 25, 19/264. *Limestone.*

SPICER'S DIGGINGS. [*See* Windeyer.]

SPION KOP. [*See* Yambulla.]

SPIRE, THE. [*See* Coal Index.]

SPLITTERS' CREEK. [*See* Albury.]

SPLITTERS' SWAMP. [*See* Bolivia.]

SPRINGBROOK, Boyd River. [*See* Dalmorton.]

SPRING CREEK. [*See* Bingara, Bungonia, Holbrook, Molong, Orange, Sofala, Stuart Town, Young.]

SPRINGDALE. [*See* Temora.]

SPRINGFIELD. [*See* Orange.]

SPRING RANGE, county of Murray, between Canberra and Morumbateman. R. 01/26. *Gold.*

SPRINGS, THE. [*See* Dubbo.]

STANNIFER. [*See* Tingha.]

STANNUM or Nine Mile, 10 miles north-west of Deepwater, 15 miles north-east of Emmaville. [*See* Vegetable Creek.]

STEPHEN'S CREEK. [*See* Broken Hill.]

STEWART'S BROOK. [*See* Moonan Flat.]

STEWART MOUNT. [*See* Dundeoo.]

STILL CREEK. [*See* Bungonia.]

STOBO, near Gulgong. [*See* Gulgong.]

Digitized by Google

STOCKYARD CREEK. [*See* Dalmorton and Stuart Town.] Near Limbri, parish of Bullimball, county of Parry, 15 miles north-east of Tamworth. R. 97/45. *Gold.*

STONY CREEK. [*See* Farley, Oberon, Orange, Stuart Town, Tingha.]

STONY BATTER, parish of Stonybatter, county of Hardinge, 20 miles south of Bundarra. M.P. 82/114. *Chromite.*

STORMY MOUNT. [*See* Barigan.]

STONY PINCH. [*See* Cudgegong.]

STRATHBOGIE. [*See* Vegetable Creek.]

STRINGY BARK. [*See* Cobborah.]

STROMBO MOUNT, or Stromlo. [*See* Oberon.]

STROUD, county of Gloucester. J.B.J. Mem. G. 2, 01/71, &c. *Iron.*

A.A. Co.'s Grant, 5 miles west-north-west of Stroud to 12 miles south-west. [*See* Clarence Town.] M.R. No. 25, 19/238. *Limestone.*

North Coast Railway, parish of Thalabah, 9 miles west of Stroud. M.R. No. 25, 19/241. *Limestone.*

STUART TOWN, late Ironbarks. [*See* Muckerwa.] Muckerwa Creek, Macquarie River, Dirt Hole, and Stockyard Creeks, Omigal, Bonada Reefs, &c., parishes of Boduldura, Burrandong, Ironbarks, and Muckerwa; Stony Creek, Stuart Town and vicinity, county of Wellington. C.S.W. 90/205; R. 02/27, 03/25, 05/23, 11/19, 14/20, 86, 15/18, 86, 16/17; Dredge 02/30, &c., to 16/25, 17/21, 18/14. *Gold.*

J.E.C. M.R. No. 6, 08/369, 373. *Copper.*

Macquarie River, ¼ mile below Muckerwa Junction. R. 83/57. *Gold.*

Yahoo, west bank of Macquarie River, near Muckerwa Creek. R. 89/62. *Gold.*

Stockyard Creek, parish of Burrandong, 6 miles north-north-east of Stuart Town. E.F.P. M.R. p. 29, D.C.McL., Diamonds in N.S.W. 99/5; R. 04/25, 05/23, 06/17. *Gold, Diamonds.*

Suttor's Bar, Katella, Macquarie River, parishes of Wear and Burrandong. C.S.W. 76/164; E.F.P. M.R. p. 385; M.P. 82/121. *Diamonds.*

Spring Creek, near Burrandong, parish of Wear. M.P. 82/103, 115; R. 85/55. *Gold, Tin, Iron.*

Old Golden Gully, Farnham. R. 14/20. *Gold* (poor).

Between Stuart Town and Mudgee. J.E.C. 97/149; M.R. No. 1, 1898. *Chromite.*

Nubrigyn Creek, parish of Nubrigyn, 6 miles south-west of Stuart Town. J.E.C. 14/193. *Phosphates in Limestone.*

Nubrigyn and Boduldura Creeks, parishes of Cooper, Ironbarks, Nubrigyn, and Warne, 5 miles south-west of Stuart Town, and 4 miles north-west to 3½ miles south-west of Eucareena. Caves. W.S.L. 96/152; R. 96/152; M.R. No. 25, 19/330, 333, 338, 340. *Limestone.*

STUBBO. [*See* Gulgong.]

STYX RIVER. [*See* The Valley.]

County of Clarke, 30 miles east-south-east of Armidale. J.E.C. M.R. No. 6, 08/311. *Copper.*

SUGARLOAF. [*See* Braidwood, Belubula River, Bateman's Bay, Newbridge, Rockley, Wilson's Downfall, &c.]

SUGARLOAFS, GREAT AND SOUTH. [*See* Coal Index.]

SUGARLOAFS, PADDY'S AND HALL'S. [*See* Vegetable Creek district.]

Digitized by Google

Summer Hill. South of Rockley, Summer Hill Creek, north-west of Rockley. [*See* Rockley, Ophir, Orange, and Tingha.]

Sunny Corner, late Mitchell's Creek, parishes of Falnash and Castleton, county of Roxburgh, south of Portland. C.S.W. 86/139; E.F.P. 84/35, 98/155; T.W.E.D. 90/239; M.R. p. 91; J.E.C. 98/165; M.R. No. 6, 08/155, 172; M.P. 82/88, 107, 118; R. 75/75, 84/52, 85/47, 86/53, 88/59, 95/55, 97/12, 29, 98/29, 01/13, 51, 54, 03/11, 04/11, 05/11, 06/43, 47, 07/47, 09/15, 10/15, 11/16, 12/15, 13/16, 47, 52, 14/49, 53, 15/49, 17/38, 41; Bores 86/177, 192, 87/179, 193, 18/36, 78. *Gold, Silver, Copper, Zinc.*

W.A. Rec. Vol. I, 1889–90; J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 270; R. 90/62. *Bismuth.*

J.E.C. M.R. No. 7, 13/17. *Mercury, with Galena and Zinc Blende.*

Parishes of Falnash and Castleton, Bobs Creek, Bull Dog Range, &c. C.S.W. 86/139; J.E.C. 98/165; R. 75/65, 93/19, 98/165, 03/11, 04/11, 05/11, 08/15, 10/15. *Gold.*

Bushrangers' Mountain, Dark Corner, Daylight Creek, Turpin's Gully, Paddy Lacky, parish of Coolamigal. R. 90/134, 92/17, 93/19, 95/17, 99/23, 00/15, 01/13, 03/11, 04/11, 05/11, 06/15, 08/15; R. 14/17, 15/15, 16/15, 17/13, 18/13. *Gold.*

Lagoon Creek. 00/15. *Gold.*

Meadow Log and Flat, parish of Falnash, south-east of Sunny Corner. J.E.C. 05/143; Mem. G. 6, 08/249; M.R. No. 14, 11/297. *Tin.*

Parish of Eusdale, south of Sunny Corner. R. 14/49. *Silver, Copper, Gold.*

Williwa Creek, between Sunny Corner and Portland. R. 93/19. *Gold.*

Mitchell's Creek, parish of Castleton, 2½ miles west-south-west of Sunny Corner. Parish of Dulabree, 13 miles north-north-west. M.R. No. 25, 19/317, 319. *Limestone.*

[*See* Ben Bullen.]

Sunnyside. [*See* Tenterfield.]

Susannah Mount. [*See* Condobolin.]

Sutherland Water. [*See* Tingha.]

Sutton. [*See* Bywong.]

Sutton Mount, New England District. J.E.C. 97/171; E.F.P. M.R. p. 302. *Tungsten.*

Sutton's Bar. [*See* Stuart Town.]

Sutton's Long Point. [*See* Macquarie River.]

Swallow's Nest. [*See* Oberon and Rockley.]

Swamp Oak (Weabonga). [*See* Niangala.] Parishes of Ainsley and Loftus, county of Parry, 25 miles east-south-east of Tamworth. G.A.S. 92/127; Rec. III, pt. 2, 1892; Rec. VI, pt. 4, 00/201; R. 91/113, 95/28, 16/19, 17/18. *Gold.*

Cockburn or Cauborn Creek, parish of Vernon, and Shearin's Creek, parishes of Ainsley and Vernon, county of Parry, 5 miles north-east of Swamp Oak; R. 81/76, 96/35, 97/45, 00/29. *Gold.*

Mullah Creek, Trib. of Swamp Oak Creek. R. 87/89. *Gold.*

Eulo, McDonald River, county of Vernon. R. 96/35. *Gold.*

Swan Brook. [*See* Inverell.]

Sydney Harbour. [*See* Coal Index.] Rec. VI, pt. 4, 00/222; M.P. 82/108, 109. *Gold* (trace.)

Digitized by Google

TABRATONG. [*See* Tottenham.]

TABULAM. Clarence River, county of Drake, 12 miles north-east of Drake. J.E.C. M.R. No. 6, 08/187. *Copper.*

Parish of Emu. M.R. No. 25, 19/222. *Limestone.*

A. 02/131. *Chromite.*

TAIT'S GULLY. [*See* Armidale.]

TALBINGO. Parish of Talbingo, county of Buccleuch, 19 miles south-south-east of Tumut. J.E.C. M.R. No. 6, 08/391; R. 08/48. *Copper, Limestone.*

Jounama and Cave Creeks, foot of Mount Talbingo, parishes of Talbingo, Boraig and Jounama. M.R. No. 25, 19/198. *Limestone.*

TALBRAGAR RIVER. [*See* Coal Index.] Dubbo and Dunedoo. Rec. VI, pt. 4, 00/243.

TALLAWANG. [*See* Gulgong.]

TALLAWIDJAH. [*See* Coramba.]

TALLEBONG. [*See* Euabalong.]

TALLONG. (Barber's Creek.) [*See* Coal Index.]

TALMALMO. [*See* Holbrook.]

TALWONG. [*See* Marulan.]

TAMBAROORA. [*See* Hill End.]

TAMWORTH. Moore Creek, parish of Tamworth, county of Inglis. R. 88/182, 96/35, 98/48. *Gold.*

Willow Tree Creek, parish of Attunga, 10 miles north of Tamworth. J.A.W. M.R. No. 4. 1898; E.F.P. M.R. p. 266. *Copper, Telluride of Bismuth.*

M.P. 82/109; Assay, 02/131. *Iron Chromite.*

Spring Creek, parish of Gill, county of Parry, 11 miles north-east of Tamworth. R. 05/17, 07/22. *Gold.*

Trough Gully, parish of Piallamore, county of Parry, 15 miles east of Tamworth. J.E.C. M.R. No. 6, 08/331; R. 01/55, 06/49, 08/50, 98, 09/59, 14/55, 15/51, 16/50. *Copper.*

[*See* Moonbi.] *Molybdenite.*

Moore Creek, parish of Woolomol, 6 to 7 miles north and north-west of Tamworth, and parish of Culala, county of Inglis, 6 miles south-east of Tamworth. *Limestone.*

Town and Common, parish of Tamworth. M.R. No. 25, 19/256. *Limestone.*

Caves, E.C.A. 05/158.

Parish of Nemingha, 6 miles east of Tamworth.

Parish of Loomberah, 7 to 15 miles south-east of Tamworth. From south-east of Nundle, north-westerly, west of Peel River to east of Tamworth, county of Parry. [*See* Nundle.] M.R. No. 25, 19/300, 304. *Limestone.*

TANGMANGAROO. [*See* Binalong.]

TANJA. [*See* Bega.]

TANNABUTTA. [*See* Cudgegong.]

TANTANGARA or Tantangra. [*See* Kiandra.]

TANTAWANGALO. [*See* Cathcart.]

TARA MOUNT. [*See* Bendemeer.]

Digitized by Google

TARAGO. [*See* Boro and Lake Bathurst.] Cullulla and Curra or Nadgigomar Creek, parish of Cullulla, county of Argyle, 11 miles east of Tarago. E.F.P. 93/107; M.P. p. 190; J.B.J. 96/135; J.E.C. M.R. No. 6, 08/341; R. 03/139, 05/45, 06/84, 07/54, 12/50.
Silver, Lead, Copper.

Nadgigomar Creek, parish of Nadgigomar, south-east of Cullulla, 13 miles east-south-east of Tarago. R. 12/50.
Copper, Gold, Silver, Lead.

Parish of Tarago, 15 miles north-west of Tarago, 11 miles south-west of Goulburn. J.B.J. Mem. G. 2, 01/104, 126. *Iron (Bauxite.)*

Windellama (Nerrimunga), parishes of Yarralaw and Cullulla. R. 82/75, 87/75, 06/85. [*See* Bungonia.] *Gold.*

R. 84/80; A. 03/140. *Cobalt, Manganese.*

M.P. 82/113. *Iron.*

Parish of Mulwaree, 1 mile south-south-west of Tarago; parish of Nadgigomar, 14 miles east. M.R. No. 25, 19/141, 142.
Limestone.

TARALGA. Mount Bunnaby, parish of Bunnaby, county of Argyle, 10 miles east of Taralga. J.E.C. M.R. No. 6, 08/363; M.P. 82/86.
Copper, Silver.

6 miles north-west of Taralga. Assay 02/131. *Iron.*

Kerraway Creek, parish of Strathaird; Cookbundoon River, parish of Kerrawery, 5 to 9 miles south-east of Taralga. M.R. No. 25, 19/145.
Limestone.

TARANA. [*See* Yetholme.] Parish of Eusdale, county of Roxburgh, 4 to 6 miles north-west of Tarana. J.E.C. M.R. No. 6, 08/174, 179; R. 06/43,47 *Silver, Copper.*

R. 18/63. *Manganese.*

Mount Tarana, parish of Eusdale. E.C.A. M.R. No. 24, 16/186.
Molybdenite.

Tennyson. Assay 07/182. *Red pigment.*

TARCOMBE PEAK. [*See* Gilgunnia.]

TARCUTTA. Tarcutta Creek, parishes of Tarcutta, Yabtree, &c., county of Wynyard. R. 79/126, 83/81, 04/27, 05/24, 06/15; Dredge 05/26, 06/26, 14/30, 15/28. *Gold.*

TAREE. Manning River, county of Macquarie, Bulbie Mountains. R. 93/23.
Gold.

20 miles north-west of Taree. R. 02/57, 05/51. *Chromite.*

Chatham Quarries, parish of Taree. R. 07/61, 08/56, 12/58, 13/62, 14/62; M.R. No. 25, 19/272. *Limestone.*

Wingham, parish of Wingham, 7 miles north-west of Taree; parish of Marlee, 4 miles north. M.R. No. 25, 19/12, 275, 276; A. 04 153, 06/180. *Limestone.*

Main Road, parish of Talawahl, county of Gloucester, 5 miles south of Timonee, 8 miles south-west of Taree. M.R. No. 25, 19/241.
Limestone.

TARLO CREEK. [*See* Goulburn.]

TARRABANDRA. [*See* Gundagai.]

TATHRA. [*See* Bega.]

TATTLAN SCRUB. 30 miles north-west of Gulgong. *Gold.*

Digitized by Google

TAYLOR'S ARM. Parishes of Herborn and Raleigh, county of Raleigh. Bowra, Sugarloaf, Buccra or Buckra, Bendinni Creek, parish of Herborn, 20 miles west-south-west of Nambucca. C.S.W. 89/204; J.E.C. M.R. No. 16, 12/26, 27; R. 02/132, 05/52, 06/56, 07/80. *Antimony.*

Baker's Creek, parish of Denison, 21 miles south-west of Nambucca; E.C.A. 07/170, 18/65. *Slate.*

TEA TREE CREEK. [*See* Barraba, Ti Tree, and Barraba.]

TEESDALE. [*See* Carcoar.]

TELARAREE. [*See* Coolongolook.]

TEMORA and vicinity. Trigalong or Wandilly Creek, parishes of Bundawarrah, &c., county of Bland. L.Y. 80/263; C.S.W. 81/136; J.E.C. Rec. Vol. I, p. 37; M.P. 82/25; Rec. VI, pt. 4, 00/234; R. 80/103, 112, 225, 85/69, 86/65, 87/66, 89/70, 95/21, 89, 04/17, 17/11, 18/11. *Gold.*

J.E.C. M.R. No. 15, 12/67. *Wolfram, Cassiterite.*

Springdale, Woodstown, Gundibindyal Creek, Possum Power, and Scrub Yards, parish of Gundibindyal, county of Bland, 9 to 14 miles south-east and east of Temora. L.Y. 79/222; C.S.W. 81/138; R. 79/102, 104, 109, 93/21, 94/76, 03/17, 74, 04/16, 05/19, 07/15, 11/13, 14/14. *Gold.*

TENANDRA. [*See* Cowra.]

TENNYSON MOUNT. [*See* Tarana and Yetholme.]

TENTERFIELD. [*See* Timbarra.] Parish of Graham, county of Clive, 8 miles north and north-west of Tenterfield. Rec. VI, pt. 4, 00/214; R. 87/101, 15/20. *Gold, Silver.*

M.P. 82/100. *Antimony.*

Barny Downs, east of Tenterfield. E.F.P. M.R. p. 62. *Gold.*

Basket Swamp, parish of Timbarra, 12 miles north-north-east of Tenterfield. R. 88/115, 98/68, 99/65. *Gold, Silver.*

Sunnyside, 5 miles west of Tenterfield. R. 04/49. *Tin.*

Near Tenterfield. E.F.P. M.R. p. 280. *Mercury.*

North-west and south-east of Tenterfield. J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 271; M.P. 82/33. Assay, 79/46, 07/177, 12/195. *Bismuth.*

J.E.C. 97/171; E.F.P. M.R. p. 303. [*See* Wunglebong.] *Tungsten.*

Sandy Creek. A. 07/176. *Arsenic.*

Wallangarra, parish of Ballandean, 8 miles north-west of Tenterfield E.C.A. M.R. No. 24, 16/148; R. 87/101, 14/65, 17/53. *Molybdenite, Tin.*

Tenterfield Creek and Common, parish of Tenterfield; The Bluff, parish of Bluff Land, 5 miles south of Tenterfield; Bungalla, parish of Strathearn, 7 miles south-south-west; parish of Addison, south-west; and parishes of Graham, Glenlyon, and Ballandean, west to north. E.C.A. M.R. No. 24, 16/147, 18/56. *Molybdenite.*

Parish of Wunglebong, 15 miles south-east of Tenterfield. E.C.A. M.R. No. 24, 16/140; R. 13/64, 18/55. [*See* Wunglebong.[*Molybdenite.*

Digitized by Google

Seven miles from Tenterfield and 13 miles south-east in the parish of Wunglebong. J.E.C. 97/171; E.F.P. M.R. p. 303; R. 13/65. *Tungsten.*

Limestone Creek, parish of Limestone, county of Clive, 19 miles west of Tenterfield. M.R. No. 25, 19/206. *Limestone.*

Wattle Creek, parish of Goolomanger, 16 miles south-east of Tenterfield. R. 17/17, 18/16. *Gold.*

Boundary Creek, parish of Goolomanger. M.R. No. 24, p. 138; 7 miles from Tenterfield and 13 in south-east in the parish of Wunglebong. J.E.C. 97/171; E.F.P. M.R. p. 303; R. 13/65. *Tungsten.*

E.C.A. M.R. No. 24, 16/147. *Molybdenite.*

TENT HILL. [*See* Vegetable Creek.]

TERALBA. 17/177. *Fire Clay.*

TERMEIL. South of Ulladulla, county of St. Vincent.
Beach. J.E.C. 04/140; R. 97/40, 05/177, 06/22. *Gold, Tin.*

TERRIBLE BILLY CREEK. [*See* Niangala.]

TERRIBLE MOUNT. [*See* Albury.]

THACKARINGA. Parish of Albert, county of Yancowinna, 12 miles south-south-west of Silverton, 20 miles west-south-west of Broken Hill. E.F.P. M.R. p. 90; J.B.J. Mem. G. 5, 94/112. *Silver.*

J.E.C. M.R. No. 6, 03/97; R. 14/87. *Copper.*

THAMES GULLY. [*See* Braidwood.]

THARWA. [*See* Queanbeyan.]

THOKO. [*See* Nimmitabel.]

THOMPSON'S CREEK. [*See* Burraga.]

THORNTON. [*See* Coal Index.]

THREDBO. [*See* Jinderbyne.]

THREE PEAK RANGE. [*See* Condobolin.]

THULLOO. [*See* Yalgogrin.]

THURGOONA. [*See* Albury.]

TIABUNDIE. [*See* Barraba.]

TIA RIVER. [*See* Walcha.]

TIBOOBURRA or The Granite. Parish of Hermitage, county of Tongowoko. C.S.W. Rec. 1, pt. 1, 89/90; E.F.P. Rec. IV, pt. 4, 1896; M.R. p. 16; R. 87/105, 89/125, 92/13, 03/11, 05/11, 07/89, 10/12, 12/11, 14/12, 15/11, 16/12, 17/11, 18/10. *Gold.*

Whittabreena Creek, south-west of Tibooburra. C.S.W. 87/137; H.Y.L.B. Report on Albert Gold Field, 81/4; R. 84/103. *Gold.*

TICHBORNE. [*See* Parkes.]

TIGERS' CAMP CREEK. [*See* Fifield.]

TIGERS' HUT. [*See* Trunkey.]

TIGHE'S HILL. [*See* Coal Index.]

TILBA TILBA. [*See* Noorooma.]

TILBUSTER. [*See* Armidale.]

TIMBER or Fell Timber Creek. [*See* Carcoar.]

TIMBERLIGHT CREEK. Parish of Meangora, county of St. Vincent, 27 miles north-north-east of Braidwood. *Gold, Copper.*

Digitized by Google

TIMBARRA. McLeod's Creek, Rocky River, parish of Cavendish, county of Clive, 6 miles south of Drake; Poverty Point, parish of Maclean, 8 miles from Timbarra. C.S.W. 89/201, 202; Rec. Vol. 1, 89/43; E.F.P. 80/245; M.R. p. 62; R. 75/58, 79/165, 83/101, 03/20, 05/16, 06/20, 08/20, 09/20, 11/22; Dredge, 01/36. *Gold.*

Parish of Goolamanger, south-south-west of Timbarra, 17 miles south-east of Tenterfield. R. 16/20. *Gold.*

Demon Creek, Trib. of Rocky River, parishes of Wunglebong, Maclean, &c., 14 miles south-east of Tenterfield, south-south-west of Timbarra. E.F.P. M.R. p. 62; R. 99/44. *Gold.*

Rocky River. E.C.A. M.R. No. 24, 16/28, 31; R. 14/65. *Gold pipes, Molybdenite.*

TIMBILLICA. [*See* Yambulla.]

TIMOR. [*See* Murrurundi.]

TINBY HILL. [*See* Yeoval.]

TINDA MOUNT. [*See* Condobolin.]

TINDARY. Parish of Ramsay, county of Robinson, 27 miles north of Cobar. Rec. VI, pt. 4, 00/214; R. 81/12, 82/102, 12/11. *Gold, Silver.*

J.E.C. M.R. No. 6, 08/210. *Copper.*

TINGEY'S PLAINS. [*See* Bombala.]

TINGHA. [*See* Copetown and Howell.] Herding Yard Gully, Stony Creek, Middle Creek, Topper's Mount, Stanifer, &c., Cope's Creek, counties of Gough and Hardinge. C.S.W. 83/151; E.F.P. M.R. p. 133, 134, 136; J.E.C. M.R. No. 14, 11/59, &c., R. 75/52, 97, 76/68, 105, 77/103, 136, 78/123, 80/149, 212, 81/81, 82/110, 00/59, 01/57, 03/50, 04/49, 05/47, 06/50, 07/55, 92, 08/52, 09/52, 10/51, 11/56, 12/52, 13/56, 14/32, 56, 15/28, 52, 16/51, 17/45, 18/43; Dredge 01/36, &c., 17/22, 18/20. *Tin.*

1½ miles east-north-east of Tingha. J.E.C. M.R. No. 6, 03/329; R. 07/55. *Copper.*

Macintyre River, Elsmore or Elmsmore and Newstead, parishes of Elmsmore and Anderson, county of Gough, 11 miles north of Tingha. T.W.E.D. Mem. G. 1, 87/2; J.B.J. 97/175; E.F.P. M.R. p. 131–6; J.E.C. M.R. No. 14, 11/43, &c.,; M.P. 82/101; R. 80/229, 99/72, 00/59, 94, 03/50, 11/57, 13/56, 16/52, 17/45, 18/44. *Tin.*

Stannifer, parish of Herbert, county of Gough. J.E.C. M.R. No. 15, 12/82. *Sheelite.*

Sheep Station Gully, Stannifer. Dredge 06/27. *Tin.*

10 miles south of Tingha. Assay 14/214. *Chromite.*

Between Macintyre River and Cope's Creek. C.S.W. Mines and Mineral Statistics 75/77; J.B.J. Mem. G. 2, 01/93. *Pisolitic Iron Ore.*

Parish of Elmsmore. J.E.C. 97/170; M.R. No. 15, 12/55; E.F.P. M.R. p. 131, 300, 302. *Wolfram.*

Newstead Tin Mine. J.E.C. M.R. No. 6, 99/88; R. 12/52. *Copper.*

Macintyre River. R. 90/106, 91/114. *Silver* (poor).

Murray Waters, Pond's Creek, Gilgai or Gilghi Creek, parish of Clive, county of Gough. R. 03/50, 05/47, 09/52, 10/51, 13/56, 14/56; Dredge 06/27, 17/22. *Tin.*

Red Hill, parish of Cope's Creek, county of Hardinge. R. 03/50, 05/47. *Tin.*

Digitized by Google

Sandy Creek, parishes of Aston, Tienga, Chigwell, county of Hardinge, 7 to 13 miles south-west of Tingha. E.F.P. M.R. p. 134. *Tin.*

Wrighton Old Village, 2 miles from Tingha. R. 75/53. *Tin.*

Sutherland Water, parish of Darby, county of Hardinge, Summer Hill Creek. Dredge 06/27. *Tin.*

Glendale near Bundarra, county of Hardinge. R. 01/57.

Sandy Creek, Hoy's Reef. J.E.C. M.R. No. 6, 08/326. *Copper, Galena, Zinc.*

Parish of New Valley, 6 miles south-east of Tingha. M.P. 82/122. *Plumbago.*

Limestone Gully, Kangaroo Creek, parish of Eden, county of Gough, 10 miles north-east of Tingha. M.R. No. 25, 19/250. *Limestone.*

Cope's Creek, Kimberley, Elmsmore, &c. C.S.W. 87/141; W.A. 87/155; E.F.P. M.R. p. 136, 388; M.P. 82/122; R. 00/61, 02/23, 08/53, 14/88, 15/54. *Diamonds.*

T.W.E.D. 91/229. *Beryl, Emeralds.*

J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 264–271; M.P. 82/33; R. 80/220; A. 04/151. *Bismuth.*

Elsmore, Middle Creek, &c., parish of Anderson, county of Gough; parish of Tienga, county of Hardinge. C.S.W. Mines and Mineral Statistics 75/85; E.C.A. M.R. No. 24, 16/148. *Molybdenite.*

TIN KETTLE CREEK or Galvins' Creek. [*See* Yerranderie.]

TIN POT. [*See* Noorooma and Warraderry.]

TIRRANA. [*See* Goulburn.]

TI TREE CREEK. [*See* Tea Tree, Barraba, Drake and Narrabri.]

TIVERTON. [*See* Holbrook.]

TOBIN'S CREEK. [*See* Sea View and Cells.] County of Hawes, 45 miles west of Port Macquarie. R. 80/154. *Gold.*

TOBINS or Arthur's Oakey. [*See* Sofala.]

TOCUMWAL. Near Murray River, county of Denison. R. 04/14. *Gold.*

TOLL BAR BRIDGE. [*See* Rock Flat Creek, Cooma.]

TOLWONG. [*See* Marulan.]

TOMAKIN. [*See* Mogo.]

TOMALLA. [*See* Moonan Flat.]

TOMINGLEY. [*See* Peak Hill.]

TOOGONG. Parish of Toogong, county of Ashburnham, 13 miles north-north-west of Canowindra. *Gold.*

Parish of Terarra, 7 miles west-north-west of Toogong. *Copper, Limestone, Cobalt.*

Assay 06/179. *Cobalt.*

TOOLONG. [*See* Dargal's Creek.]

TOOLOOM. Fraser's Gully, Mount McDonald, &c., Tooloom Creek, parishes of Tooloom, Clarence and Porcupar, county of Buller, 18 to 20 miles east and north-east of Wilson's Downfall. R. 91/124, 95/28, 01/31, 05/16, 06/20, 11/22. *Gold.*

TOOMA. [*See* Tumbarumba.]

TOONALLOOK. [*See* Holbrook.]

TOORAWEANAH. [*See* Warrumbungles.]

TOPPER'S MOUNT. [*See* Tingha.]

Digitized by Google

TOROKA CREEK. [*See* Kempsey.]

TORRINGTON. [*See* Vegetable Creek.] Cow Flat, Catarrh Mountain. *Tungsten, Bismuth, &c.*

Mole Tableland, parishes of Annandale, Bates and Rockvale, county of Clive, and parish of Highland Home, county of Gough, 12 to 15 miles north-east of Emmaville. E.F.P. M.R. p. 132; J.E.C. M.R. No. 14, 11/158, 329; R. 11/57, 13/57, 14/57, 88, 15/, 53, 94, 16/53, 93, 17/46, 86, 18/45, 84.; Dredge 18/21. *Tin.*

J.E.C. M.R. No. 15, 12/53, 58, &c.; R. 00/67, 05/54, 06/59, 96, 07/65, 08/59, 09/59, 10/57, 11/64, 13/65, 89, 14/66, 15/61, 94, 16/93, 17/51, 86, 18/58, 84. Assay 05/181; J.E.C. and E.C.A. 18/152. *Wolfram, Tungsten.*

J.E.C. and E.C.A. 18/152; R. 05/52, 07/63, 09/57, 10/56, 15/94. *Bismuth.*

J.E.C. M.R. No. 15, 12/90. *Cobalt.*

TORROWANGEE. Poolamacca Holding, county of Farnell, 30 to 36 miles north-north-west of Broken Hill. C.S.W. 87/141; E.F.P. M.R. p. 147; R. 86/111; Assay 07/183. *Tin.*

Parishes of Alberta, Coonbaralba, and Torrowangee, county of Farnell. J.B.J. Mem. G. 5, 94/44; R. 95/69; M.R. No. 25, 19/229. [*See* Corona and Euriowie.] *Limestone.*

TOTTENHAM. Orange Plains, Albert Water Holes, Mount Royal, &c., parishes of Carolina, Albert, Beaconsfield, and Tabratong, county of Kennedy. J.E.C. 99/184, 09/179; M.R. No. 6, 08/p. 254, &c., 17/152; R. 82/42, 99/47, 00/55, 01/55, 05/45, 06/47, 94, 07/53, 03/47, 95, 09/47, 76, 10/47, 11/52, 12/49, 13/52, 14/53, 87, 15/49, 97 (09/76 Bore); R. 16/17, 48, 17/42, 18/76; A. 06/180. *Gold, Silver, Copper, and Iron.*

Honeybugle, parish of Honeybugle, county of Flinders, 30 miles north-west of Tottenham, 24 miles south-west of Nymagee. L.Y. 80/262. *Gold, Copper.*

TOUGA. Touga and Quiera Creeks, parish of Touga, county of St. Vincent. 9 to 14 miles north and north-north-west of Nerriga. J.B.J. 96/134; J.E.C. M.R. No. 6, 03/366, 367; R. 83/75, 07/81. *Copper, Gold and Silver traces.*

TOWAMBA RIVER. County of Auckland, 12 miles south-west of Eden, between Eden and Bombala. Rec. VI, pt. 4, 00/199; R. 83/76, 87/75, 13/26, 15/24. *Gold, Silver.*

TOWER HILL. [*See* Dalmorton.]

TOWRANG. [*See* Goulburn.]

TRANGIE. County of Narromine, 12 miles north of Trangie. Assay 04/153. *Gypsum.*

TRAFFITTS BALD HILL. [*See* Orange.]

TRIGALONG CREEK. [*See* Temora.]

TROFFS. [*See* Trundle.]

TROOPERS MOUNT. Sandy Creek, Snowy River, parish of Mount Trooper, county of Wellesley. J.E.C. 97/159; M.R. No. 6, 08/390. *Copper with Silver.*

TROUGH GULLY. [*See* Tamworth.]

TROWEL CREEK or Whitbarrow. [*See* Nymagee.]

Digitized by Google

TRUNDLE. Mordealloc Station, parish of Plevna, county of Cunningham. J.E.C. M.R. No. 6, 08/278, 281; R. 08/48, 09/11, 48, 10/47, 11/12, 53, 12/12, 13/13, 18/77. *Ironstone, Gold, Copper, Silver.*

Botfields, parish of Botfields, portions 10 and 13, 3½ miles south-east of Trundle. A. 07/180. *Iron.*

Trundle and The Troffs, parishes of Botfields, Gillenbine, Plevna, Sebastopol, and Trundle. M.R. No. 25, 19/215, 216, 217. *Limestone.*

TRUNKEY or Arthur. Between Copperhannia and Mulgunnia Creeks, tributary of Abercrombie River, Mulgunnia Creek, parish of Mulgunnia, county of Georgiana, south of Newbridge. C.S.W. 77/205; G.A.S. Rec. III, pt. 1, 92/8; Rec. VI, pt. 4, 00/218; R. 75/60, 76/75, 03/12, 04/12, 05/11, 06/16, 07/18, 08/16, 09/15, 10/16, 11/17, 12/15, 14/17, 15/16, 16/15, 17/14. *Gold.*

M.P. 82/117, 122; R. 79/46. *Diamonds, Wad.*

Copperhannia Creek, parishes of Copperhannia and Mulgunnia. R. 13/17. *Gold.*

Mount Grey, Grove Creek, parish of Bombah, 7 to 10 miles south-east of Trunkey. J.E.C. M.R. No. 7, 13/17, 21; R. 75/60, 63. *Gold, Mercury, &c.*

Bombah, parish of Bombah. J.E.C. M.R. No. 6, 08/174. *Copper.*

Parishes of Groveland and Kempfield, east and west of Trunkey. Assay 16/220. *Manganese.*

R. 18/62. *Barytes.*

Pine Ridge or Hell Hole, parish of Bombah, 8 miles south of Trunkey. R. 76/75, 95/17, 06/12, 11/17, 15/16. *Gold.*

Alma Dam. R. 05/12, 08/16. *Gold.*

Craig Lea, parish of Carrawa, 5 miles north of Trunkey. R. 03/12, 05/12, 06/16, 07/18, 08/16, 13/17, 15/16, 16/15. *Gold.*

Mount Dudley, Colo Creek, Mountain Run, parish of Kempfield, 5 miles north-west of Trunkey. R. 93/19, 94/21, 95/17, 14/17, 15/16, 17/13, 18/13; Dredge 11/29. *Gold.*

Kirkmans, Kempfield, Scabbing Flat, parish of Kempfield, Rocky Bridge Creek, Tigers Hut, &c., 3 miles west to 5 miles north-west of Trunkey. J.E.C. M.R. No. 6, 08/149, 174; R. 00/55. *Copper.*

M.M. 18/162; R. 01/14, 13/16, 14/17, 87, 15/15, 16/15, 17/13. *Gold.*

Pembroke, parish of Groveland, 6 miles east of Trunkey. R. 11/17. *Gold.*

Rocky Bridge Creek, west and south-west of Trunkey. C.S.W. 77/207; W.A. Rec. III, pt. 1, 92/29; E.F.P. M.R. p. 398; M.P. 82/179; R. 75/60, 05/49. *Opal.*

Abercrombie Caves, Grove Creek, 7 miles south-east of Trunkey. N.S.W. Magazine 1843, p. 223; Well's Geographical Dictionary or Gazetteer of the Australian Colonies, 1848, p. 48; C.S.W. 77/206; Proc. Linn. Soc. N.S.W. 79/460; W.S.L. 94/157; O.T. 97/205 and plan, 99/plan, 01/70; Caves Guide 1906. *Limestone.*

Parish of Abercrombie, 5 miles south-south-west of Trunkey. M.R. No. 25, 19/233. *Limestone.*

TUCKERS HILL. [*See* Hargraves.]

TUCKLAN. [*See* Cobborah.]

Digitized by Google

TUENA. Mount Costigan, parish of Tuena, county of Georgiana, 2 miles south-south-east of Tuena. G.A.S. Rec. III, pt. 1, 1892; J.E.C. M.R. No. 6, 08/158; R. 87/49, 88/58, 11/17, 12/48, 13/47, 14/53, 87, 15/49, 16/48. *Silver, Copper.*

Scrubby Rush, parish of Tuena, 3 miles north of Tuena, near Abercrombie. R. 83/46, 87/49, 94/21. *Gold.*

J.E.C. M.R. No. 6, 08/174. *Silver, Copper.*

Parishes of Yarraman, Tuena, &c. G.A.S. Rec. III, pt. 1, 1892; J.B.J. 95/178; Rec. V, pt. 4, 00/224; R. 75/64, 76/36, 99/22, 02/14, 03/12, 04/12, 07/18, 15/16, 16/16. *Gold.*

Parish of Yarraman, 1 mile south of Tuena. J.B.J. Mem. G. 2, 11/144. *Iron.*

Sounding Rock, parish of Yarraman, 6 miles north-west of Tuena. J.E.C. M.R. No. 6, 08/174. *Gold, Silver, Copper.*

Cordillera, parish of Kangaloola, 5 to 7 miles south-east of Tuena. J.E.C. M.R. No. 6, 08/140.; R. 88/58, 15/45. *Gold, Silver, Copper.*

J.E.C. 97/170; M.R. No. 15, 12/85, 86, 88, 94; E.F.P. M.R. p. 298, 302; M.M. 06/172; R. 99/76, 10/57. *Tungsten, Sheelite, Stolzite.*

Peelwood, parish of Kangaloola, 8 miles south-south-east of Tuena. G.A.S. Rec. III, pt. 1, 1892; J.E.C. M.R. No. 6, 08/161; R. 75/22, 76/36, 76, 78/99, 80/78. *Copper.*

Hillside. R. 94/21. *Gold.*

Cooks Vale Creek, parish of Bingham. *Silver.*

Junction Point or Gillendich, parishes of Blackman and Gillindich, 8 miles south of Tuena; Dog Trap, 6 miles south of Junction Point. R. 75/64, 76/75, 82/35, 95/17, 98/27, 04/12, 05/12, 03/15, 10/16, 11/17, 12/15, 13/17, 14/18, 17/14, 18/13. *Gold.*

R. 11/52. *Copper.*

Meglo, parish of Meglo, 7 miles south-west of Tuena. R. 11/17. *Gold, Silver, Copper.*

J.E.C. M.R. No. 16, 12/40; M.P. 82/100. *Antimony.*

Abercrombie River, parish of Bombah, 3½ miles north-north-east to north-north-west of Tuena, parish of Yarraman, near Limestone Creek, and at Tuena. [*See* Trunkey.] M.R. No. 25, 19/296. *Limestone.*

TUGLOW. Parishes of Abercorn and Banshea, county of Westmoreland, 20 miles south-south-east of Oberon. J.E.C. 99/180, M.R. No. 6, 08/174; R. 98/28, 71; 99/67, 06/47, 07/52; Assay 98/184. *Copper with Gold.*

TUGLOW CAVES. [*See* Jenolan.]

TUGRABAKH. [*See* Gloucester.]

TULLAMORE. [*See* Fifield.]

TUMBARUMBA. Parish of Tumbarumba, county of Selwyn. W.A. 89/230; Rec. II, pt. 1, 90/21; J.E.C. 94/114, 121; 02/123; Rec. VI, pt. 4, 00/196; R. 75/93, 76/101, 02/28, 05/28, 06/15, 09/14, 10/15, 11/15, 12/14, 13/15, 14/16, 15/14, 16/14, 17/12, 18/12; Dredge 01/36, &c., to 16/26. *Gold.*

J.E.C. M.R. No. 14, 11/269; Dredge 05/26. *Tin.*

Assay 04/152 *Tungsten.*

R. 90/95. *Asbestos* (poor).

Digitized by Google

Laurel Hill, Bago Creek, Cherry Hill, parish of King, county of Selwyn, 10 miles north-east of Tumbarumba. J.E.C. 02/123; M.R. No. 14, 11/268; R. 94/26, 95/23, 00/26, 01/26, 02/7, 14/85, 15/14, 16/14, 18/12. *Gold, Tin.*

Burra Creek, parish of Burra, county of Selwyn, 5 miles south-east of Tumbarumba. J.E.C. 94/114, M.R. No. 6, 99/164; M.R. No. 14, 11/163; R. 76/101, 92/43, 01/26, 04/50, 07/58, 16/82, 18/46; Dredge 04/29, &c. *Gold, Silver, Copper, Tin.*

Maragle, parishes of Maragle and Wallace, county of Selwyn, 12 miles south-east to 18 miles east of Tumbarumba. E.C.A. M.R. No. 10, 01/31; R. 87/83. *Gold.*

Tumbarumba Creek, Tooma, parish of Tooma, county of Selwyn, 12 miles south-south-east of Tumbarumba. J.E.C. 02/123; R. 84/87; Dredge 06/26. *Gold.*

Quartzville. R. 01/87. *Gold.*

Rosewood. R. 90/95. *Cobalt, Manganese* (poor).

American Yards, Humula, parishes of Umbargo and Humula, county of Wynyard, 24 miles north-west of Tumbarumba. R. 95/23. *Gold.*

Carabost, parishes of Carabost and Bulagee, 20 miles north-west of Tumbarumba. R. 87/93, 95/23. *Gold.*

Tarcutta, parishes of Tarcutta and Yabtree, north-west of Adelong. R. 79/126, 05/24, 06/18; Dredge 05/26, 06/26, 14/30, 15/28, 16/26. *Gold.*

TUMBLONG. [*See* Gundagai.]

Lacmalac, Goobarragandra River, parish of Mundongo, county of Buccleuch, 6 miles east of Tumut. R. 76/125, 14/16, 85, 15/14, 16/14. *Gold, Tin.*

Assay 04/153, 12/195. *Barytes.*

Sandy Creek, parish of Blowering, 4 miles south-east of Lacmalac. Dredge 01/36, 03/29, 04/20, 07/28. *Gold.*

R. 17/47, 18/46. *Tin.*

Red Hill, Brungle Creek, and Wyangle, parish of Brungle, north of Tumut, parish of Wyangle, north-east of Tumut; O'Heher's Bridge, Tumut River, 3 miles east to 15 miles south-east of Tumut.

L.Y. 80/258; J.E.C. M.R. No. 6, 08/374, 376, 383, 395, 396; R. 79/124, 02/50, 12/14, 13/15, 14/16. *Copper, Silver, Gold* (trace).

Brungle, Wendowie, and Wyangle. R. 79/124, 15/85, 18/62. *Arsenic.*

Brungle Creek. J.E.C. 97/149; M.R. No. 1, 1898. *Chromite.*

Parish of Mundongo. J.E.C. 95/127; 97/150; M.R. No. 1, 1898. *Chromite.*

6 to 20 miles east of Tumut. M.P. 82/108, ; R. 06/178; Assay 04/15, 07/177. *Iron, Chromite.*

Sandy Creek, parish of Cooleman, 13 miles east of Tumut. J.E.C. 00/183; M.R. No. 14, 11/284. *Tin.*

Parish of Nimbo, 15 miles east-south-east of Tumut. R. 09/14. *Gold.*

Goobarragandra River, near Junction Baloo Arm, parish of Baloo, county of Buccleuch, 13 miles south-east of Tumut. R. 02/50, 16/49, 82, 17/42, 18/12, 83. *Gold, Copper.*

Digitized by Google

Bumbolee Creek, parishes of Wyangle and Mundongo, 7 miles north-east of Tumut; Adjunbilly Creek, parish of Darbalara, 16 miles north of Tumut, and south-easterly; parish of Wyangle, county of Buccleuch. L.F.H. 16/208; R. 06/14, 12/14, 13/87, 14/16, 15/14, 84, 16/14, 82; Dredge 01/36, 12/26, 13/29. *Gold.*

South side of Mount Lightning. J.E.C. 95/126, 97/148; M.R. No. 1, 1898. *Chromite.*

Serpentine Belt, from Muttama to Lacmalac. J.E.C. M.R. No. 6, 08/374, 382. *Copper.*

Argalong, 16 miles east of Tumut. R. 06/14; Dredge 06/26, 09/26, 11/29, 17/12, 18/12. *Gold.*

Bumbolee Creek, parish of Wyangle, 7 miles north-east of Tumut. M.R. No. 25; 19/199. *Limestone.*

Billapaloola, 15 miles north of Tumut. R. 95/23, 01/25, 87. *Gold.*

TUNCURRY. [*See* Halliday's Point.]

TUNGSTEN. [*See* Torrington.]

TURLINGAH. [*See* Moruya.]

TURLEY'S HILL. [*See* White Cliffs.]

TURON RIVER. [*See* Hill End, Capertee and Sofala.] County of Roxburgh. Rec. VI, pt. 4, 00/202, 207, 218, 224; Parliamentary Papers, G.F. of N.S.W., 1873–4. R. 75/28, 99/27, 03/29, 04/29; Dredge 01/35. *Gold.*

Rec. VI, pt. 4, 00/314. *Platinum.*

E.F.P. M.R. p. 385; M.P. 82/122; D.C.McL., Diamonds in N.S.W., 1899, Rec. VI, pt. 4, 00/299, 303. *Diamonds.*

TURON RIVER (UPPER). Rec. VI, pt. 4, 00/211, 214, 242; R. 04/19, 05/15. *Gold.*

TURONDALE. [*See* Sofala.]

TUROSS RIVER. [*See* Noorooma.] Wadbilliga Creek, parish of Wadbilliga, county of Dampier, 27 miles west-south-west of Noorooma. Rec. VI, pt. 4, 00/214. *Gold.*

TURRAWAN. [*See* Coal Index.] Parish of Turrawan, county of White, south-east of Narrabri. J.E.C. 14/195; R. 14/61, 15/56; A. 14/214. *Iron ore, Hematite.*

TUTTLAN SCRUB. [*See* Cobborah.]

TWEED RIVER HEADS. County of Rous. E.C.A. 04/145. *Basalt quarry.*

TWILL CREEK. 60 miles from Taree. R. 95/26. *Gold.*

TYAGONG or Bumbaldry Creek. [*See* Grenfell.]

TYRINGHAM. Grafton Road, Blick's River, parish of Tyringham, county of Fitzroy. *Gold.*

UARGON CREEK. [*See* Coal Index.]

UAMBY CREEK. Parish of Wondaby, county of Bligh, 20 miles south-west of Gulgong. R. 81/46. *Gold.*

ULLADULLA. Parish of Ulladulla, county of St. Vincent. L.F.H. 06/170; R. 01/66, 09/60, 10/59. *Pottery Clay.*
L.F.H. 18/158; A. 16/228, 18/170. *Quartzite.*

ULMARRA. Clarence River, near Grafton, county of Clarence. Assay 97/191. *Antimony, Gold and Silver (traces).*

ULMARRAH CREEK. [*See* Hill End.]

Digitized by Google

UMARALLA, now Numeralla. Big Badja River, parishes of Undoo and Rose Valley, county of Beresford. J.E.C. M.R. No. 6, 99/49; R. 88/97. *Gold, Silver, Copper.*

Fiery and Undoo Creeks, north-north-west of Umaralla, parishes of Abercrombie, Clifford, Undoo, and Rose Valley. W.A. 84/232; Rec. VI, pt. 4, 00/197; R. 88/97, 97/38. *Gold.*

Rosebrook, parishes of Umaralla and Rose Valley. J.E.C. M.R. No. 6, 08/381, 388, 391, 392; R. 08/48. *Copper, Gold, Silver, Lead.*

Parishes of Undoo, Rivers, and Lucas, 3 miles east to 6 miles south-east of Umaralla. M.R. No. 25, 19/190, 192, 193. *Limestone.*

UMBERUMBERKA. [*See* Broken Hill.]

UNDERCLIFF MOUNTAIN. Parish of Bookookoorara, county of Buller, 9 miles east of Maryland. L.H.Y.B. 82/149; E.F.P. M.R. p. 371; E.C.A. 01/170; R. 82/96, 88/111, 89/113, 98/75, 00/66, 04/56, 11/66, 15/62, 16/62, 17/58, 18/62. Assay 04/153. *Plumbago, Graphite.*

UNDOO CREEK. [*See* Umaralla.]

UNGARIE. Parishes of Ungarie and Wollongough, county of Gipps, 17 miles north-north-east of Yalgogrin. J.E.C. M.R. No. 16, 12/46. Assay 03/140. *Gold, Silver, Tin, Antimony.*

UNNGALA CREEK. Parish of Guroba, county of Bligh, 23 miles south-west of Gulgong. R. 02/22. *Gold.*

URALLA. Rocky River, Sawpit Gully, Mounts Walsh, Brisbane, Jones, Sherwood, Mutton, Copeland. &c., parishes of Arding, Devon, and Uralla, county of Sandon. T.W.E.D. 86/153; G.A.S. 95/162; E.F.P. M.R. p. 11, 62, Rec. VI, pt. 4, 00/196, 200, 203, 226; M.P. 82/24; R. 75/98, 76, 68, 70, 81/86, 95/27, 97/84, 99/41, 00/28, 01/36, 03/21, 05/17, 07/21, 11/21, 12/18, 13/21, 14/22, 15/19, 16/19, 17/16, 18/15; Dredge 01/36, &c. *Gold.*

M.P. 82/122. *Gems, Diamonds.*

Easterly and 12 miles east of Uralla. J.E.C. M.R. No. 15, 12/86. *Tungsten, Sheelite.*

Doherty's Hill, Mount Butler, &c., north of Uralla. T.W.E.D. 86/153. *Gold.*

Parish of Gostwick, county of Sandon, 6 miles south-east of Uralla. R. 13/21, 15/19. *Gold.*

Kentucky, parish of Kentucky, county of Sandon, 8 miles south-west of Uralla. J.A.W. M.R. No. 4, 1898; E.F.P., M.R. p. 271, Rec. VI, pt. 4, 00/201; Assay 96/143. *Telluride of Bismuth.*

J.E.C. M.R. No. 16, 12/47; M.P. 82/100; Assay 06/178. *Antimony.*

M.P. 82/102, 107, 114. *Chromite, Iron, Tin.*

Dredge 07/28. *Gold.*

Honeys Creek, between Uralla and Kentucky. M.P. 82/102. *Gold, Tin.*

Near and 16 miles north-west of Uralla. Assay 04/152, 06/180; R. 18/63. *Manganese.*

Goldsworth. R. 18/62. *Arsenic.*

Balala, west of Uralla, county of Hardinge; R. 99/41. *Gold.*

Honeysuckle Creek, parish of Honeysuckle, county of Hardinge, 15 miles north-west of Uralla. M.P. 82/102, 103. *Tin.*

URAMBIE. [*See* Euabalong.]

Digitized by Google

URANA. County of Urana. J.E.C. 99/179; R. 99/31. *Gold.*

URIARA or Urayarra. [*See* Coree.]

UTOPIA MOUNT. [*See* Noorooma.]

VALE OF CLWYDD. [*See* Coal Index.] County of Cook, north-east of Lithgow. E.F.P. M.R. p. 1; M.P. 82/80. *Gold.*

VALLEY, THE. Back Creek, Serpentine and Styx Rivers, parish of Cunnawarra, county of Clarke, 5 miles south of Guy Fawkes, 27 miles east-north-east of Hillgrove. M.M. 14/208; E.C.A. M.R. No. 24, 16/90. *Molybdenite.*

VEGETABLE CREEK (Emmaville). 15 miles west of Deepwater, 36 miles south-west of Tenterfield. The Vegetable Creek Tinfield comprises the south-east part of the county of Arrawatta, the northern part of the county of Gough, and the north-west part of the county of Clive. It includes The Mole Tableland and the mining centres of Emmaville, Stannum (Nine-mile), parish of Wellington Vale, county of Gough. Torrington (*see* separate reference), and country west of Deepwater. Comprehensive reports. T.W.E.D. Mem. G. 1, 1887; J.E.C. M.R. No. 14, 11/51, 122, 155, 320, &c. Other references.

Mines and Mineral Stat. 75/63–70; C.S.W. 83/148; T.W.E.D. 83/155, 84/153; E.F.P. M.R. p. 130, 141; E.C.A. 03/131; M.P. 82/27, 102; Rec. VI, pt. 4, 00/319, 320; R. 75/52, 98, 76/110, 77/141, 78/126, 79/149, 80/143, 157, 213, 231, 81/96, 82/88, 110, 83/102, 107, 89/105, 135, 99/73, 96, 02/52, 03/50, 04/49, 05/48, 06/51, 07/57, 92, 08/26, 52, 97, 09/52, 10/51, 11/57, 12/53, 13/57, 14/57, 15/53, 16/53, 17/45, 18/44, 84; Dredge 06/27, &c., to 16/27, 28, 17/23, 18/20. *Tin.*

Little Plant Creek (Webb's), parish of Strathbogie North, county of Gough; Pye's Creek, parishes of Fraser and Annandale, county of Clive. T.W.E.D. Mem. G. 1, 87/156, 159; E.F.P. M.R. p. 107, 112; J.E.C. M.R. No. 15, 12/69; E.C.A. 01/170; Rec. VI, pt. 4, 00/323; R. 84/88, 102, 95/55, 99/96, 06/43, 15/46. [*See* Webb's Consuls.] *Silver Lead.*

Little Plant Creek, Pye's Creek, Glen Creek, &c. T.W.E.D. Mem. G. 1, 87/160; J.E.C. M.R. No. 6, 08/305, 306, 308, 312; R. 84/101, 85/81, 86/80, 91, 98/61. *Copper.*

Cow Flat, Silent Grove, Glen Creek, Pye's Creek, &c. [*See* Torrington.] T.W.E.D. 91/230; Mem. G. 1, 87/163; J.A.W. M.R. No. 4, 1898; E.F.P. M.R. p. 264, 270, 271; E.C.A. 04/143; J.E.C. M.R. No. 15, 12/68, 90; Rec. VI, pt. 4, 00/345; R. 80/220, 04/43, 05/52, 07/63; Assay, 07/177. *Bismuth.*

Gulf Creek, Glen Creek, Hall's Grampians, Paradise Creek, &c. [*See* Torrington.]

Gulf G. Smith, 18/76. *Fluorspar.*

Mines and Mini. Stat. 75/71; T.W.E.D. Mem. G. 1, 87/161, 162; E.F.P. M.R. p. 130, 298, 299, 303; E.C.A. 04/143, 05/151; J.E.C. 97/169, 171; M.R. No. 15, 12/50 to 96; R. 98/75, 05/54, 06/59, 07/65, 12/61, 13/65, 90, 18/59. *Tungsten.*

T.W.E.D. 91/229; Mem. G. 1, 87/164, 165; E.F.P. M.R. p. 406, 408, 410; Rec. VI, pt. 4, 00/302; R. 90/104, 120, 91/126, 08/61, 09/54. *Emeralds, Gems, Sapphires.*

T.W.E.D. Mem. G. 1, 87/162; J.B.J. Mem. G. 2, 01/93, 104; Trans. G.S.A., vol. 1, p. 24. *Iron, Laterite, Bauxite.*

Digitized by Google

T.W.E.D. Mem. G. 1, 87/160, 163. *Antimony, Arsenic, Manganese, Zinc.*
T.W.E.D. 91/165; E.F.P. M.R. p. 435. *Pipe Clay.*
Clive, Pye's Creek, and The Gulf. T.W.E.D. Mem. G. 1, 87/163; R. 75/111. *Gold.*
T.W.E.D. Mem. G. 1, 87/166. *Limestone.*
Glen Creek, &c., parish of Bundar, county of Gough, 5 miles north of Emmaville. T.W.E.D. Mem. G. 1, 87/146, 163; E.C.A. 03/131; M.R. No. 24, 16/120. *Molybdenite.*
Haystack Mount, near junction Dumaresq and Beardy Rivers, parishes of Haystack and Dumaresq, county of Gough, 20 miles north-west of Emmaville; E.C.A. M.R. No. 24, 16/121. *Molybdenite.*
Beardy Creek. Assay, 16/219. *Bismuth.*

VICTORIA MOUNT. [*See* Coal Index.] Yorkey's Creek, 11-mile peg, Mount Victoria to Jenolan Caves, county of Westmoreland. [*See* Lowther.] J.E.C. M.R. No. 6, 08/179; Assay, 07/176. *Arsenic, Copper.*

VIOLET CREEK. [*See* Drake.]

WAALIMMA. [*See* Yambulla.]

WAGGA WAGGA. Murrumbidgee River. Town Common, counties of Clarendon and Wynyard. J.E.C. 94/119; R. 94/27, 77, 99/33. *Gold.*
R. 13/58; Assay, 06/181. *Tin.*
R. 05/54. *Wolfram.*

WAGONGA. [*See* Noorooma.]

WAGRA. [*See* Wymah.]

WAGRAGOBILLY. [*See* Gundagai.]

WALBUNDY. [*See* Bulgandry.]

WALCHA. Europambula Run, Blue Mountain Creek, parishes of Winterbourne and Gill, county of Vernon, 6 to 19 miles north-east of Walcha. J.E.C. M.R. No. 6, 08/321, 332; R. 02/49, 06/83, 07/55, 08/50, 09/50. *Copper, Silver.*
McLeod's Creek, Tia River, parishes of Shelving and Tiara, 17 to 21 miles south-east of Walcha. Rec. VI, pt. 4, 00/200; R. 78/125, 80/155, 06/19, 07/22. *Gold, Tin.*
Walcha or Orundunby Station, south-west of Walcha. J.E.C. M.R. No. 16, 12/47; R. 81/87, 95/27,; Assay 07/176. *Antimony.*
Winterbourne Station, 20 miles north-east of Walcha. E.C.A. 04/145; R. 03/67, 143. *Graphite.*
District. J.E.C. 97/150. *Chromite.*
South-south-west and east of Walcha. Assay, 06/180, 07/181. *Manganese.*
Graveyard Creek, near Apsley Gorge, parish of Fenwick. E.C.A. 05/151; J.E.C. 08/166; R. 07/66. *Slate.*

WALCH'S CREEK. [*See* Nowendoc.]

WALDEGRAVE. Parish of Waldegrave, county of Bathurst. M.R. No. 25, 19/129. *Marble, Limestone.*

WALLABY ROCKS. [*See* Cadia.]

WALLACE TOWN. County of Clarendon, south-west of Junee. R. 14/15. *Gold.*

WALLAGA LAKE. County of Dampier, 4 miles north of Bermagui. R. 80/131. *Gold.*

Digitized by Google

WALLAGOOT. County of Auckland, north of Pambula. R. 88/84. *Silver.*

WALLAH WALLAH. [*See* Boorowa.]

WALLANGARRA. [*See* Tenterfield.]

WALLANGRA. Macintyre River, county of Arrawatta, north-west of Ashford. Rec. VI, pt. 4, 00/200; R. 91/121. *Gold.*

WALLANGULLA. Lightning Ridge, parish of Wallangulla, county of Finch, 36 miles west of Collarindabri. J.B.J. 05/68; Inspector G. Smith, 17/71; R. 03/52, 04/51, 05/49, 06/53, 07/59, 08/53, 54, 09/54, 10/52, 11/58, 12/55, 13/59, 14/60, 15/55, 16/54, 17/48, 18/47. *Opal.*

Grawin, parishes of Mein and Morendah, 19 miles south-west of Wallangulla. R. 08/54. *Opal.*

WALLAROO RANGE. [*See* Cowra.]

WALLAYA. [*See* Kiama.]

WALLENDBEEN. Parish of Nubba, county of Harden; Berthong, parish of Berthong, county of Bland, 1 mile north to 6 miles north-west of Wallendbeen. J.B.J. 95/170; Rec. V, pt. 1, 1896; J.E.C. M.R. No. 1, 1898; R. 17/55, 18/62; Assay, 02/130, 06/180, 12/195. *Chromite, Asbestos, Gold* (trace.)

Parish of Nubba. R. 01/22. *Gold.*

R. 09/60, 10/59, 11/65, 12/62, 13/67, 14/68, 15/63, 17/56. *Soapstone Steatite.*

M.M. 18/161; R. 14/65, 15/62, 16/63, 17/56. *Kaolin Pigments.*

WALLERAWANG. [*See* Coal Index.] 150, 155 parish of Falnash, county of Cook, and 413, parish of Falnash, county of Roxburgh, south-west of Piper's Flat, 7 miles west of Wallerawang; 93, parish of Thornshope, county of Roxburgh, north-west of Rydal. Trans. R. Soc. of N.S.W., 1874, p. 81–91; Mines and Minl. Stat. N.S.W., 75/94, 103; C.S.W. 91/213; E.F.P. 99/168; M.R. p. 201–205; Iron Ore Deposits of N.S.W., 1910; J.B.J. 99/190; Mem. G. 2, 01/58, 145, 146, 158; J.E.C. Mem. G. 6, 08/234; M.P. 82/28, 105, 108, 110; Rec. VI, pt. 4, 00/305; R. 83/36; Assay 83/36, 02/131. *Iron.*

M.P. 82/100. *Antimony.*

Brunt's Creek, parish of Falnash, county of Cook, 5½ miles north-north-west of Wallerawang. M.P. 82/171–173; M.R. No. 25, 19/206; R. 75/141. *Limestone, Marble.*

WALLSEND. [*See* Coal Index.]

WALL'S SIDING, near Mudgee. R. 17/56. *Dolomite.*

WALSH'S CREEK. [*See* Nowendoc.]

WAMBAN CREEK. [*See* Moruya.]

WAMBERRIGA RANGE. [*See* Milparinka.]

WAMBOYNE. [*See* Billy's Lookout.] Parish of Bona, county of Gipps, near Lake Cowal. L.F.H. 06/170; R. 06/13, 85, 07/15. *Gold.*

WAMBROOK. [*See* Berridale.]

WANDELLOW. [*See* Noorooma.]

WANDEALLABA CREEK. [*See* Warrumbungles.]

WANGAT. Parish of Wangat, county of Gloucester, 16 miles north-north-west of Dungog. R. 81/91, 95/20, 06/21, 07/80, 08/20, 11/24. *Gold.*

Redbank, Lower Wangat. R. 95/26. *Gold.*

Upper Wangat. R. 94/29, 95/26. *Gold.*

Parish of Hewong, north of Wangat. R. 16/21. *Gold.*

WANGWAUK. [*See* Coolongolook.]

Digitized by Google

WANTABADGERY STATION. Parish of Wantabadgery, county of Clarendon, 16 miles south-east of Junee. R. 89/90, 98/39. *Gold* (poor).

WANTIALABLE CREEK, or Wandiallabah Creek. [*See* Warrumbungles.]

WANTIOOL. [*See* Junee.]

WARBROBROOK. Parish of Warbro, county of Dudley, 20 miles north-west of Kempsey. M.R. No. 25, 19/225. [*See* Kempsey.] *Limestone.*

WARDELL. [*See* Coal Index.]

WARD'S MISTAKE. [*See* Kookarabooka.]

WARIALDA. Parish of Adams, county of Burnett, south of Warialda. J.E.C. M.R. No. 6, 08/332; Assay 07/176, 181.
Copper, Chromite, Antimony, Limestone.

Pine Creek, 12 miles south-west of Warialda. A. 04/151, 07/183. *Tin.*

Slaughterhouse Creek, parish of Singapoora, county of Burnett, 19 miles south-west of Warialda. G.A.S. 95/160. Rec. VI, pt. 4, 00/200.
Gold, Magnesite.

Slaughterhouse Range, parishes of Ellis and Fletcher, county of Courallie, parish of Monson, county of Burnett, 22 miles south-west of Warialda. M.R. No. 25, 19/209. *Limestone.*

Kelly's and Ti-Tree Creeks, parish of Warialda; Oaky Creek, Hallam's Spring, or Sugarloaf Creek, parish of Adams, county of Burnett, 1 mile east to 10 miles south of Warialda. M.R. No. 25, 19/129, 201.
Marble, Limestone.

Croppa or Cox's Creek, near Hughey's Arm Creek, Gunyerwarildi station, parish of Cox, county of Burnett, 25 miles north-west of Warialda.

Gwydir River, 1½ miles east of Yagobie Station, parish of Gravesend, 18 miles west-south-west of Warialda. M.R. No. 25, 19/202.
Limestone.

WARGUNDY. [*See* Dunedoo.]

WARM CORNER. [*See* Chandler River.]

WARNING MOUNT. Parish of Burrell, county of Rous, 8 miles south of Murwillumbah. J.E.C. M.R. No. 6, 08/191. *Copper.*

WARRADERRY RANGE, late Tin Pot. Parish of Warraderry, county of Forbes, 17 miles north-west of Grenfell. J.B.J. 00/185; R. 99/28, 00/22, 93.
Gold.

WARRAMBUCCA. [*See* Braidwood.]

WARRATTA RANGE and Creek. [*See* Milparinka.]

WARRATRA. [*See* Hargraves.]

WARRELL CREEK. [*See* Nambucca.]

WARRENGUNYAH. [*See* Ilford.]

WARRI. [*See* Braidwood.]

WARRUMBUNGLES. Breeding Creek, Tooraweanah, parishes of Naman and Tooraweanah, county of Gowen. E.F.P. Rec. VIII, pt. 3, 07/187; H. I. Jenson, Proc. Linn. Soc. XXXII, pt. 3, 1907, p. 586.
Gems, Opal.

Wandiallabah and Uargon Creeks, south-west of Coonabarabran. E.F.P. M.R. p. 427; T.W.E.D. Proc. Linn. Soc. XXI, pt. 2, 1896, p. 261; H.I.J. Proc. Linn. Soc. XXXII, pt. 3, 1907, p. 583; G.W.C. and W.S.D., Rec. V, pt. 3, 97/144; M.P. 82/101; R. 87/165, 96/146.
Tripolite.

WASHPOOL CREEK. [*See* Lionsville.]

Digitized by Google

WATERFALL STATION, county of Cumberland. J.B.J. Mem. G. 2, 01/105. *Ferruginous Bauxite.*

WATSON'S CREEK. [*See* Bendemeer.]

WATTLE CREEK. [*See* Tenterfield.]

WATTLE FLAT. [*See* Sofala and Turon River.]

Big and Little Oakey Creeks, Solitary Creek, Paling Yards, &c., parishes of Sofala and Wingen, county of Roxburgh, south of Sofala. J.B.J. 96/128; Rec. VI, pt. 4, 00/209; R. 75, 28, 82/45, 94/23, 99/23, 00/15, 01/13, 02/13, 05/11, 06/15, 07/18, 08/15, 09/15, 10/15, 11/16, 12/15, 13/16, 14/16, 17, 15/15, 16/15, 17/13, 18/13; Dredge 11/29. *Gold.*

Redbank. R. 95/19, 04/11. *Gold.*

Solitary Creek, parish of Sofala. R. 82/35, 84/59, 94/23; Dredge 09/26, 11/29. *Gold.*

WAUCHOPE. [*See* Hastings River.]

Parish of Koree, south of Hastings River, county of Macquarie; King Creek, near Wauchope, 13 miles west-south-west of Port Macquarie. J.E.C. M.R. No. 6, 08/263, 265; R. 07/80; Assay, 04/153, 06/180; M.R. No. 25, 19/272. *Copper, Limestone.*

Near Broken Bago, parish of Koree, 7 miles south-west of Wauchope. R. 07/80. *Gold.*

WAUGOOLA. [*See* Woodstock.]

WAUKERGO. [*See* Purnamoota.]

WAVERLEY. [*See* Murrurundi.]

WEABONGA. [*See* Swamp Oak.]

WEANDRE CREEK. [*See* Molong.]

WEBB'S. [*See* Vegetable Creek.]

WEBB'S CONSULS. [*See* Wellingrove.]

WEBB'S CREEK. South-east corner, county of Hunter, 35 miles north-west of Sydney. R. 08/60. *Pigments.*

WEDDIN MOUNTAIN. [*See* Sandy Creek and Grenfell.]

WEAN CREEK. Parish of Nullama, county of Arrawatta, 12 miles north-east of Byron. *Silver.*

WEARE'S CREEK. Nundle. M.P. 82/119. *Nickel.*

WEE JASPER. Murrumbidgee River, county of Buccleuch, 26 miles north-east of Tumut.

E.F.P. M.R. p. 270. *Gold, Bismuth.*

WEE WAA. 25 miles south. A. 12/197. *Magnesite.*

WELAREGANG. Murray River, south of Tumbarumba, county of Selwyn. R. 96/31. *Gold.*

WELLINGROVE. Mount Galena, Webb's Consols, Reedy and Ti-Tree Creeks, parish of Gordon, county of Gough, 10 miles south-west of Emmaville.

T.W.E.D. Mem. G. 1, 87/160; E.F.P. M.R. p. 114; Rec. Vol. I, 89/66; M.P. 82/86; R. 75/111, 84/102, 88/98, 91/125, 06/43, 14/50, 88, 15/47, 95, 16/44, 18/37. *Silver, Lead.*

Assay, 06/181, 07/176. *Zinc, Arsenic.*

Wellingrove Creek, Severn River, parishes of Fladbury and Gordon. G.A.S. 94/136; R. 77/109. *Tin.*

Parish of Wellington, east of Wellingrove. R. 16/52, 17/45. *Tin.*

Digitized by Google

WELLINGTON. Apsley, &c., Macquarie and Bell Rivers, parish of Wellington, county of Wellington. Dripstone, parish of Yarragal, county of Bligh, east of Wellington. [*See* Bungiebomar and Bodangora.]

C.S.W. 76/161, 78/69, 90/206; J.E.C. M.R. No. 6, 08/290, 302, 303; Rec. VI, pt. 4, 00/242; R. 80/98, 88/72, 02/22, 05/79, 06, 18, 47, 07/21, 08/18, 19, 47, 09/18, 10/19, 16/48, 17/42. *Copper.*

Macquarie River. R. 77/71; Dredge, 06/26 to 13/29, 16/28. *Gold.*

Burril Range, parish of Galwadgere, county of Wellington, south-east of Dripstone.

J.E.C. M.R. No. 6, 08/285, 290, 302; R. 82/43, 83/51; Dredge, 11/28. *Gold, Copper.*

Parish of Wuuluman, county of Bligh, 10 miles east of Wellington. R. 95/19, 03/19, 05/79, 08/19, 09/18, 10/19, 14/21, 15/19, 17/16. *Gold.*

Klondyke, Jaw Bone, parishes of Nanima and Yarragal, county of Bligh, east of Wellington.

Parish of Wellington, county of Wellington.

J.E.C 14/191; R 14/68, 15/63, 16/63, 17/56, 18/64; Assay, 16/220. *Phosphates.*

Jawbone, R. 16/18. *Gold.*

Catombal, or Kadumble Range, county of Gordon, south of Wellington. J.E.C. M.R. No. 6, 99/123, 167. *Copper.*

W.A. Rec. 111, pt. 1, 1892. *Opal.*

6 and 10 miles east of Wellington; M.P. 82/118; Assay, 14/216, 16/220. *Magnesite.*

District, R. 10/59. *Pigments.*

Black Mountain, Macquarie River, 10 miles above Wellington. R. 77/70, 06/26; Dredge, 08/24. *Gold.*

Gunner's Dam, parish of Veech, county of Gordon, 14 miles south of Wellington.

C.S.W. 90/206; R. 08/19, 09/18, 14/21, 15/19, 16/18. *Gold.*

Bell River, parish of Narragal, county of Gordon, 16 miles south of Wellington. *Copper, Tungsten.*

Geurie, parish of Micketymulga, county of Lincoln. J.E.C. M.R. No. 6, 08/300; R. 88/70. *Copper.*

Parishes of Geurie, Micketymulga, Macquarie and Wooroobomi, between Dubbo and Wellington. M.R. No. 25, 19/266, 271. *Limestone.*

Burran Burran Caves, parish of Nanima, county of Bligh, 4 to 5½ miles east to north-east of Wellington [*See* Spicer's Creek.]

C.S.W. 76/162; Rec. VI, pt. 4, 06/242; M.R. No. 25, 19/194, 336. *Limestone.*

Apsley, Dripstone, &c., parishes of Mumbil and Wellington, county of Wellington, 1 mile south-west to 6 miles south-east of Wellington.

Wellington Caves, 4 miles south of Wellington.

Sir T. Mitchell, 1831. Mitchell's Australia, 1838, XV, Vol. 2, p. 347.

C. Sturts' Two Explorations into Southern Australia, 1834, XXXV, Vol. 1.

S. Stutchbury. Geol. and Mining Survey of N.S.W. 23-1-1852.

E. Kreft and Dr. A. M. Thompson. Parliamentary papers. Wellington Caves, 1870. Exploration of Caves and Rivers of N.S.W. 1882.

C.S.W. 76/162; R.E. 91/269; O.T. 97/plan, 00/209, Caves Guide, 1906; M.R. No. 25, 19/9, 312-344. *Limestone.*

Digitized by Google

Newrea Creek, parishes of Newrea and Narragal, county of Gordon. Parish of Mumbil, county of Wellington, 8 and 9 miles south-east, and 10 to 17 miles south of Wellington. M.R. No. 25, 19/245, 337. *Limestone.*

Curra Creek, Macquarie River, parishes of Ponto, Curra and Gundy, county of Gordon. From Wellington 7 miles south-west to 9 miles north-west. M.R. No. 25, 19/242, 243, 248. *Limestone.*

Bell River, parish of Ironbarks, 13 miles south-south-east of Wellington. Macquarie River, parish of Burrandong, county of Wellington, 14 miles south-east of Wellington. M.R. No. 25, 19/333. *Limestone.*

Doughboy and Burrawong Creeks, Myrangle, parishes of Burrawong, Burgoon, Eurimbla, and the Gap, county of Gordon, near Cumnock, 6 to 14 miles north-west of Molong. M.R. No. 25, 19/249. *Limestone.*

WELLINGTON VALE. [*See* Vegetable Creek.]

WELLWOOD. [*See* Lucknow and Orange.]

WENDOWIE. [*See* Tumut.]

WENTWORTH. [*See* Lucknow and Orange.]

WERONG MOUNT. Head of Abercrombie River, parishes of Wyndham and Werong, county of Georgiana, south and 1 mile west of Mount Werong, 25 miles south of Oberon.

LY. 80/264; R. 94/21, 95/17, 01/15. *Gold.*

Lanigan's Creek, parish of Banshee, county of Westmoreland, 2 miles north-east of Mount Werong. Ruby Creek.

J.E.C. 99/183; R. 88/53, 08/42, 09/93, 10/44, 11/48, 86, 12/44, 13/47, 14/84. *Silver, Lead, Zinc.*

J.E.C. M.R. No. 14, 11/296. *Tin.*

Parish of Abercorn, county of Westmoreland, north of Mount Werong.

E.F.P. 05/137; R. 05/48. *Gems, Diamonds* (?).

WERTAGO. [*See* Nuntherungie.]

WESTBROOK CREEK. [*See* Coal Index.] County of Durham, 3 miles east of Singleton. C.S.W. 84-151. *Limonite in thin layers.*

WEST MAITLAND. [*See* Coal Index.]

WESTMACOTT MOUNT. [*See* Coal Index.]

WEST HILL. [*See* Woodstock.]

WET CREEK. [*See* Currickabark and Noorooma.]

WHALAN'S HILL. [*See* Sofala.]

WHEOGA MOUNT. [*See* Sandy Creek.]

WHIPSTICK. [*See* Pambula.]

WHITE CLIFFS. Momba Run, Bunker's and Turley's Hills, Gemville, 11 miles south-west of White Cliffs, parish of Kirk, county of Yungnulgra. J.B.J. 92/140; E.F.P. M.R. p. 399; Rec. IV, pt. 4, 1896; Report Royal Com. Leg. Ass., 1901; Rec. VI, pt. 4, 00/301; R. 93/50, 95/68, 83, 97/66, 98/77, 99/78, 00/61, 01/61, 02/54, 03/52, 04/51, 05/49, 06/53, 92, 07/59, 88, 08/54, 09/54, 10/53, 11/59, 12/55, 13/59, 14/60, 15/55, 16/55, 17/48, 18/47. *Opal.*

Parnanga, near White Cliffs. R. 98/78. *Opal.*

Above opal-bearing rocks *Gypsum.*

WHITE ROCK. [*See* Drake.]

WHITTABREENA. [*See* Tiboburra.]

WHITTAKER'S CREEK. [*See* Noorooma and Wagonga.]

Digitized by Google

WIAGDON. [*See* Sofala and Limekilns.]

WILBETREE. [*See* Mudgee.]

WILCANNIA. Parishes of Dalgleish and Parkes, county of Young, 34 miles south-west of Wilcannia. C.S.W. 84/147; R. 01/33. *Gold.*

WILGA DOWNS, or Wilgar. County of Canbelego, south of Girilambone. R. 01/33, 89, 03/14, 10/46, 97, 11/52, 90. *Gold, Copper.*

WILGABONE. [*See* Girilambone.]

WILGA, MOUNT. [*See* Euabalong.]

WILLIWA CREEK. [*See* Sunny Corner.]

WILLAWARRIN. Macleay River, county of Dudley, 20 miles north-west of Kempsey. Assay 03/140, 07/176. *Tin, Antimony.*

WILLEROO. County of Argyle, north-east of Lake George. C.S.W. 84/146. *Iron.*

WILLIAMS' RIVER. [*See* Clarence Town, Dungog, &c.] 20 miles north-west of Dungog, county of Gloucester. J.E.C. M.R. No. 16, 12/47. *Antimony, Gold, Silver.*

WILLI WILLI. Head of Warbrobrook Creek, parish of Panton, county of Dudley, 30 miles west-north-west of Kempsey. J.E.C. M.R. No. 6, 08/265; R. 99/68, 01/55, 03/50; A. 04/151. *Silver, Copper.*
Assay, 07/181; M.R. No. 25, 19/131, 222, &c. *Limestone.*

WILLYAMA. [*See* Broken Hill.]

WILSON'S DOWNFALL (Liston.) Amosfield Herding Yard, Ruby, Cemetery, and Wylie Creeks, parishes of Cory, Ruby, &c., county of Buller, 12 miles south-south-east of Maryland. J.E.C. M.R. No. 14, 11/83, 231, 329; R. 77/154, 03/51, 04/49, 06/52, 07/58, 08/53, 11/58, 13/57, 14/57, 15/53, 17/46, 18/44; Dredge 01/36 to 05/48, 17/23. *Tin.*
Maryland Creek, parish of Maryland. H.Y.L.B. 82/149; R. 75/56. *Tin.*
Wilson Mount, parish of Koreelah, 21 miles by road from Acacia Creek. M.M. 10/181; R. 11/23. [*See* Coal Index.] *Gold.*
Division, R. 17/55. *Graphite.*
Cemetery Creek, parish of Ruby. J.E.C. M.R. No. 15, 12/53, 58, 59, 61, 67, 77, 18/60. *Wolfram.*
Sugarloaf Mountain, Maryland, &c., parishes of Ruby and Wylie, county of Buller, 3½ miles north to 10 miles north-west of Wilson's Downfall. E.C.A. M.R. No. 24, 16/166. *Molybdenite.*

WILSON RIVER. [*See* Port Macquarie.]

WINBURNDALE RIVULET. [*See* Bathurst.]

WINDELLAMA. Narra Numbea or Nerrimunga. [*See* Bungonia and Tarago.]

WINDEYER. [*See* Hargraves.] Clarkes', Gugiong and Barraba Creeks, Eaglehawk Gully, parish of Windeyer, county of Wellington, 16 miles north-north-east of Tambaroora; Spicer's Diggings, Meroo and Campbell's Creeks, parish of Warratra, 5 miles north-east of Windeyer. R. 75/74, 79/86, 95/19, 96/27, 99/25, 00/16, 02/21, 03/18, 04/19, 05/14, 06/18, 07/20, 08/18, 20, 09/17, 10/18, 11/19, 13/19, 14/20, 15/18, 16/18, 17/15, 18/15. *Gold.*
Campbell's or Guigong Creek, Upper Meroo. J.E.C. M.R. No. 16, 12/3, 46. *Antimony, Cobalt, Mercury.*

WINGECARRIBEE RIVER. Wingecarribee Swamp, Kangaloon and Burrawong Creeks, county of Camden, west and south-west of Robertson. C.S.W. 90/210; R. 90/86, 91/96. *Gems, Sapphires, Zircons.*

Digitized by Google

WINGELLO. [*See* Coal Index.] Patrick's Creek, Paddy's River, Murrimba, parish of Wingello, county of Camden, west and north-west of Wingello. R. 94/28. *Gold.*

Assay, 02/131. *Red Ochre.*

Parishes of Wingello, Bumballa, and Murrimba. J.B.J. 99/187; Mem. G. 2, 01/85, 103, 158; E.F.P. 99/162; Iron Ore deposits of N.S.W., 1910. *Bauxite Aluminous Iron Ore.*

Parish of Casura, south-east of Wingello. R. 17-38. *Silver* (doubtful.)

West of Ballany's Trig. Station, parish of Bumballa, 2¼ miles south-south-west of Tallong, 7 miles south-west of Wingello. M.R. No. 25, 19/204. *Limestone.*

Douglas Park. Assay, 04/153. *Limestone.*

WINGEN. [*See* Coal Index.] Parish of Wingen, county of Brisbane. G.W.C. Rec. IV, pt. 1, 1894. E.F.P. M.R. p. 436 *Fullers' Earth.*

J.E.C. 14/195; M.P. 82/105; Assay, 02/131. *Iron.*

R. 75/97, 79/205. *Silver, Sulphur.*

WINGHAM. [*See* Taree.] Dingo Creek, Manning River, parish of Lewis, county of Macquarie, between Wingham and Cooplacuripa. J.E.C. M.R. No. 1, 1898; Assay, 02/131, 06/178. *Chromite, Manganese.*

Assay, 04/153, 06/180. *Limestone.*

WIRE GULLY. [*See* Carcoar.]

WIRLONG. [*See* Nymagee.]

WISEMEN'S CREEK. [*See* Oberon.]

WOLGAN RIVER. [*See* Coal Index.]

WOLLOMOMBI. [*See* Hillgrove.]

WOLLONDIBBY. Parish of Wollondibby, county of Wellesley, 14 miles west of Delegate. R. 15/24. *Gold.*

WOLLONDILLY RIVER. [*See* Goulburn and Picton.]

Limestone Creek, parish of Bangadilly, county of Camden, 20 miles west of Mittagong. M.R. No. 25, 19/203. *Limestone.*

WOLLOGOLONG or Wologalong. [*See* Molong.]

WOLLONGONG. [*See* Coal Index.] R. 12/62, 14/68. *Fireclay.*

WOLUMLA. Mount Momson, parishes of Wolumla and Cobra, county of Auckland, 8 miles north-west of Pambula. J.E.C. 96/122, 97/162; R. 96/33, 97/42, 99/37, 03/24, 04/24, 05/22, 76, 06/23, 07/25, 80, 08/22, 10/23, 11/25, 12/22, 13/25, 14/26, 84, 15/24, 16/22, 80, 17/19. 18/17; A. 96/143. *Gold.*

R. 02/26, 12/43; Assay, 03/139. *Silver.*

A. 14/214. *Barytes, Bismuth.*

WOMBAT. [*See* Young.]

WOMBEYAN CAVES. Wombeyan and Mares Forest Creeks, parishes of Bounerie and Guineacor, county of Westmoreland, 42 miles west of Bowral, 49 miles north of Goulburn. Dr. J. Cox, Trans. Philosophical Soc. N.S.W., 1862–1865, p. 197. Spéléologie Bulletin No. 21, Vol. 5, Nos. 2 and 17. L.Y. 79/227; T.W.E.D. 84/8, 85/129, 96-149; W.S.L. 88/203, 89/253, 92/177, 94/158, 96/151; O.T. 97/appendix, 98/193, 99/211, 01/177, 03/136, 07/174; Guide Book; M.R. No. 25, 19/344. *Marble, Limestone.*

Digitized by Google

WONDALGA. [*See* Adelong.]

WOMBRAMURRA CREEK. [*See* Nundle.]

WONGABAH. [*See* Rivertree.]

WONGARBON. Murrumbidgere, parish of Barbigal, county of Lincoln. Assay 12/196. *Hematite.*

WONGRABELLE. [*See* Yambulla.]

WONNAMINTA STATION. County of Mootwingee, west of Koonenberry. R. 03/47. *Copper.*

WOODBURN. McAuley's Lead, Jerusalem Creek, Esk River, and Beach Sands, parish of Esk, county of Richmond. J.E.C. 95/149, 99/179; M.R. No. 14, 11/295, Rec. V, pt. 2, 1897; E.F.P. M.R. p. 9 and 77; R. 96/155, 98/54, 06/20, 58, 08/25, 09/58; Dredge 09/26. *Gold, Platinum, Tin.*

WOODFORD. [*See* Coal Index.]

WOOD'S FLAT. [Sec Woodstock.]

WOOD'S TOWN. [*See* Temora.]

WOOD'S REEF. [*See* Barraba.]

WOODSTOCK. Belmore, Wood's Flat, parish of Kenilworth, county of Bathurst. C.S.W. 78/150; J.E.C., M.R. No. 6, 08/175, 176, 270; Rec. Vol. I, 89/38; R. 75/65, 76/77. *Copper, Gold.*

Burly Jacky, parish of Walli, 4 miles north of Woodstock; J.E.C. M.R. No. 6, 08/116; R. 91/69. *Copper.*

J.B.J. 95/180; R. 08/16, 09/16, 10/16. *Gold.*

Waugoola Creek, parish of Waugoola, 5 miles south-east of Woodstock, Westhill, 4 miles south-west; J.E.C. M.R. No. 6, 08/171, 175; R. 81/38. *Copper.*

Parish of Walli, 1 mile south-west of Waugoola Platform; parish of Kenilworth; J.B.J. Mem. G. 2, 01/130; E.F.P. Iron Ore Deposits of N.S.W., 1910. Assay, 04/152, 07/181. *Iron.*

WOOGOOLGA. [*See* Beach.] Champion and Corindi Creeks, county of Fitzroy, north and west of Woogoolga. J.E.C. M.R. No. 7, 13/17, 41; G.W.C. 00/33, 194; R. 10/58. *Mercury.*

Corinda Creek, parish of Woogoolga. R. 91/135, 96/36, 03/13, 05/13, 08/20. *Gold.*

Maclean River 06/20. *Gold.*

Sea Coast, county of Fitzroy, Yarrawhara Creek. J.B.J. 16/78; Assay, 16/220. *Magnetic Iron.*

WOOLAMIN. [*See* Wuuluman, under Wellington.]

WOOLOMIN. [*See* Tamworth.]

WOOLBROOK. County of Inglis, 25 miles east of Tamworth. Assay 02/131. *Chromite.*

WOOLGARLO. Good Hope, Yass River, parish of Woolgarlo, county of Harden, 17 miles south-west of Yass. J.E.C. 04/138; M.R. No. 6, 08/352, 353, 368; J.E.C. and E.C.A. 14/190; R. 95/94, 16/43. *Copper, Silver, Galena.*

R. 75/94, 15/62, 16/62, 17/55, 18/62. *Fluor Spar.*

WOOLGOOLGA. [*See* Woogoolga.]

WOOLOMIN. [*See* Nundle.]

WOOLOMOMBI. [*See* Hillgrove.]

Digitized by Google

WOY WOY CREEK. [*See* Nambucca.]

WOY WOY, 4 miles south-west. Assay, 16/220. *Red Ochre, Iron.*

WRIGHTON. [*See* Tingha.]

WRIGHTVILLE. [*See* Cobar.]

WUNGLEBONG. Boundary Creek, Rocky River, parishes of Wunglobong and Goolomanger, county of Clive, 15 miles south-east of Tenterfield. [*See* Tenterfield.] E.C.A. M.R. No. 24, 16/135, 143; R. 13/65, 14/88, 15/60, 16/59, 18/55, 60. *Molybdenite, Bismuth, Wolfram.*

Wuuluman. [*See* Wellington.]

WYALDRA or Home Rule. [*See* Gulgong.]

WYALONG, parish of Wyalong, county of Gipps, parishes of Mugga and Narragudgil, county of Bland. E.F.P. 94/105, 99/164; M.R. p. 28–36; Rec. IV, pt. 2, 1894; J.A.W. M.R. No. 5, 1899; L.F.H. 09/184, 12/186; R. 94/25, 73, 95/21, 98/36, 99/30, 00/23, 01/23, 02/20, 03/17, 74, 04/17, 05/19, 06/13, 85, 07/15, 08/12, 09/12, 10/13, 11/13, 93, 12/12, 68, 13/14, 14/14, 86, 15/13, 85, 16/13, 17/12, 18/11, 82. *Gold.*

Buddigower, parish of Buddigower, county of Bourke, 12 miles south-west of Wyalong. E.F.P. 01/158; J.E.C. M.R. No. 14, 11/275; R. 01/58, 174, 05/48, 06/52. *Tin.*
R. 01/51, 87, 06/43, 07/47. *Silver.*
R. 96/11. *Gold.*

Hiawatha or Nine-mile, north of Wyalong. R. 00/24. *Gold.*

Parishes of Younga Plain and Ugalong, county of Gipps, 14 miles north-west of Wyalong. R. 13/58, 14/58, 16/52. *Tin.*

Sydney Morning Herald, 21/7/97; 2 miles south of Wyalong. *Opal.*

WYANBENE. Wyanbene Creek, Shoalhaven River, parish of Wyanbene, county of Dampier, 25 miles south of Braidwood. *Silver.*

Wyanbene Caves. Rev. W. B. Clarke, Geol. Sur. of N.S.W., letter to Col. Sec., 21/10/51; W.S.L. Papers Mines Misc. 89/1404, 97/21925, O.T. 99/213, 00/198; M.R. No. 25, 19/218.

Cheitmore Caves, parish of Tallanganda, county of St. Vincent, 6 miles north of Wyanbene Caves. O.T. 00/198; M.R. No. 25, 19/9, 218. *Limestone.*

WYANGLE. [*See* Tumut.]

WYBONG CREEK, county of Brisbane, halfway between Scone and Merriwa. T.W.E.D. 89/213. *Salt.*

WYLIE CREEK. [*See* Wilson's Downfall.]

WYMAH, late Wagra, parish of Wagra, county of Goulburn, 25 miles east-north-east of Albury, near Murray River. J.E.C. M.R. No. 15, 12/76; R. 15/50, 85, 18/60. *Copper, Tungsten.*

WYNDHAM. [*See* Pambula.]

WYRALLAH. [*See* Lismore.]

YABTREE. [*See* Tarcutta.]

YAGOBIE. [*See* Warialda.] Gwydir River, parish of Yagobie, county of Burnett, 22 miles east of Moree. R. 89/62; G.A.S. 95/160. *Gold.*

YAHOO. [*See* Stuart Town.]

Digitized by Google

YALGOGRIN. [*See* Kolkilberto and Rankin's Springs.]

Parish of Brolga, county of Gipps, 25 miles west of Wyalong. J.B.J. 95/180; R. 93/62, 94/25, 95/22, 97/82, 98/37, 00/14, 01/24, 03/17, 51, 05/19, 06/14, 07/16, 08/13, 09/13, 10/13, 11/14, 12/13, 13/14, 14/15, 15/13, 16/13. *Gold.*

Pine Grove, Tulloo, parish of Thulloo, county of Gipps, 10 miles north-west of Yalgogrin. R. 08/13, 11/14, 13/14. *Gold.*

Mulyan, parish of Kikoira, county of Dowling, 10 miles north-west of Yalgogrin. J.E.C. M.R. No. 14, 11/278; J.B.J. 06/74; L.F.H. 07/173; R. 06/53, 07/58, 08/52, 14/58, 18/45. *Gold, Tin.*

Parish of Bolagumy, 8 miles north-east of Yalgogrin. R. 16/53. *Tin.*

West and north-west of Yalgogrin. J.E.C. M.R. No. 15, 12/62, 77; R. 15/61, 17/54, 18/61. *Wolfram.*

Restdown, 17 miles south-west of Yalgogrin, parish of Euratha South. R. 03/14, 13/65, 16/82, 17/12, 88, 18/61. *Gold, Tungsten.*

R. 17/47. *Tin.*

Narriah, parish of Narriah, county of Cooper, 10 to 17 miles west of Yalgogrin. R. 99/71, 01/58, 03/51, 11/58. *Copper, Tin.*

10 to 14 miles south-west. R. 94/25, 17/12. *Gold.*

Parishes of Gorman's Hill and Wilga South, county of Gipps. R. 16/13. *Gold.*

YALLOCK. [*See* Holbrook.]

YALLOCK RUN, county of Mossgiel, 90 miles north-west of Hillston. R. 89/127. *Gold.*

YALWAL. Parish of Danjera, county of St. Vincent. E.F.P. 83/159; M.R. p. 59; E.C.A. M.R. No. 9, 1901; Rec. Vol. I, pt. 2, 1889, p. 50; R. 75, 87, 79/122, 83/75, 87/73, 88/83, 90/90, 91/97, 94/28, 99/35, 00/18, 02/25, 03/23, 05/20, 06/21, 07/24, 08/20, 09/21, 11/24, 12/21, 13/23, 14/25, 84, 15/22, 16/21. *Gold.*

Shoalhaven River, Grassy Gully, parish of Buangla, north of Yalwal. J.B.J. Rec. VII, pt. 1, 00/17; E.C.A. M.R. No. 9, 1901; R. 98/42, 99/35, 00/18, 15/22, 83, 16/21, 80. *Gold.*

Bundundah Creek, parish of Ettrema; E.F.P. 83/160; J.E.C. M.R. No. 6, 08/327; R. 83/75, 84/77. *Copper.*

Right arm, Yalwal Creek, parish of Yalwal. R. 87/74, 88/83, 89/134. *Silver.*

A. 02/131. *Mag. Iron Ore.*

Ettrema Lodes, Ettrema Creek, parish of St. George, 12 miles south-west of Yalwal. [*See* Ettrema.] M.R. No. 25, 19/327. *Limestone.*

YAMBLE. [*See* Gulgong.]

YAMBULLA. Timbillica Reefs, Spion Kop, Razorback, parishes of Yambulla, Nungatta, and Waalimma, county of Auckland. J.E.C. 96/122; J.B.J. 01/164, 165; R. 95/26, 96/34, 97/42, 98/45, 99/37, 01/20, 84, 02/26, 74, 03/25, 04/25, 05/22, 78, 06/23, 84, 07/25, 80, 08/22, 09/23. 10/23, 11/25, 86, 12/23, 79, 13/25, 85, 14/85, 15/24, 16/23, 17/19. *Gold.*

Assay, 02/133. *Silver, Copper* (traces).

J.E.C. 97/159; M.R., No. 14, 11/286. *Tin.*

YANCO CREEK. [*See* Drysdale.]

YANKO GLEN. [*See* Broken Hill.]

Digitized by Google

YANCOWINNA CREEK. Parish of Yancowinna, county of Yancowinna, 20 miles north-east of Broken Hill. J.B.J. Mem. G. 5, 94/133. *Tin, Gold.*

YANKEE CREEK. [*See* Peter's Grass.]

YANTABULLA. Centre of county of Irrara. *Gypsum.*

YANTALLA. [*See* Cangai.]

YARARA. [*See* Coppabella.]

YARRABELLE. [*See* Shooter's Hill.]

YARRAGEE. [*See* Moruya.]

YARRAGAL. [*See* Wellington.]

YARRAHAPINI. [*See* Nambucca.]

YARRANGOBILLY. [*See* Lobb's Hole.] Parish of Yarrangobilly, north and south of the Caves, 42 to 50 miles south of Tumut. W.A. 86/164; J.E.C. M.R. No. 6, 08/396, 398; R. 14/54. *Copper.*

J.E.C. 00/184; R. 88/94, 96/47. *Silver.*

Blue Creek, Yarrangobilly River, between Lobb's Hole and the Caves. J.E.C. M.R. No. 6, 08/375; R. 10/48, 11/53, 12/49, 13/52, 14/54, 15/49, 16/49. *Copper.*

Parishes of Yarrangobilly, The Peaks, Boraig, and Pinboyan, county of Buccleuch, 26 to 36 miles east-south-east of Tumut. Yarrangobilly and Copper Mine Caves. W.A. 87/163; *Illust. Sydney News*, 28/3/91 and 11, 25/4/91; W.A. and W.S.L. 91/249, 282; O.T. 97/207, 230; 99/plans, 06/173, 10/182, 13/185, 15/190, 17/173; Caves Guide, 2nd ed., 1917; L.F.H. 12/179; M.R. No. 25, 19/200. *Limestone.*

YARRAS. [*See* Jasper Peak.]

YARRCALKIARRA. [*See* Gordon Brook.]

YARRALUMLA. Molonglo River, near Canberra, county of Murray. J.E.C. M.R. No. 6, 08/365. *Copper.*

YARROW RIVER. [*See* Kingsgate.]

YARROWYCK. Parishes of Yarrowick and Barlow, county of Hardinge, 20 miles west of Armidale. J.E.C. M.R. No. 16, 12/47; R. 06/56, 07/62. *Antimony, Gold, Silver.*

YASS. Yass River, counties of King and Murray. Above and below Yass and parish of Martin, county of King, east of Yass; Rec. VI, pt. 4, 00/199; R. 14/27. *Gold.*

Derringullen Creek, near and north-west of Yass; R. 83/76. *Copper.*

Red Hill, head of Boorowa Creek, county of King. J.E.C. M.R. No. 6, 08/366; R. 95/26, 03/27. *Gold, Copper, and Ironstone.*

Near Yass and 8 miles west at Bogalong. M.P. 82/107, 114, 118; Assay, 13/189; R. 75/94. *Manganese, Iron.*

Sharpening Stone Creek. J.E.C. M.R. No. 16, 12/46; M.P. 82/100. *Antimony.*

Bloomfield, Remington, Silverdale, near Bowning. R. 05/42. *Silver.*

Sapling Point, parish of Boambolo, county of Murray, 12 miles south of Yass, south-west of Murrumbateman. J.E.C. M.R. No. 6, 08/366. *Copper.*

Gooda Creek, parish of Weir, county of Murray, 4 miles south of Murrumbateman. J.B.J. 96/138; J.A.W. 97/187; J.E.C. M.R. No. 6, 08/363. R. 96/31, 97/39, 99/34, 05/24. *Gold, Copper, Silver.*

Digitized by Google

Kirkdale. R. 07/53, 63, 10/56; Assay, 07/177. *Copper, Bismuth.*

Limestone Creek, 6 miles north-west of Yass; R. 83/76. *Lead.*

Limestone Creek, parishes of Derringullen and Yass, county of King, 4 miles north-west of Yass, parish of Hume, county of Murray at Yass.

Limestone Creek, parish of Jerrawa, county of King, 10 miles north-east of Yass, parish of Bango, 6 miles north-east of Yass; M.R. No. 25, 19/260. *Limestone.*

Goodradigbee River, parishes of Taemas, Cavan and Narrangullen, county of Cowley.

10 miles south-west to 11 miles south-south-west of Yass. [*See* Goodradigbee River.] L.F.H. Rec. IX, pt. 1, 09/11, 40.

Cavan Caves. R.E. Rec. III, pt. 2, 92/68; M.R. No. 25, 19/199, 209. *Limestone.*

Murrumbidgee River, parishes of Boambolo and Warroo, county of Murray. 8 to 12 miles south of Yass. L.F.H. Rec. IX, pt. 1, 09/11, 40; M.R. No. 25, 19/209, 282. *Limestone.*

Parish of Jeir, Queanbeyan to Yass Road. M.R. No. 25, 19/289. *Limestone.*

18 miles south of Yass. Assay, 16/219. *Bismuth.*

YELLOW CREEK. [*See* Drake.]

YELLOW MOUNTAIN. [*See* Condobolin.]

YELLOW SPRINGS. [*See* Corang River.]

YELLOW WATERHOLES. [*See* Vegetable Creek.]

YEOVAL. Buckinbah Reefs.

Goodrich, Little River, parish of Bolderodgery, county of Gordon, 5 miles west-south-west of Yeoval. Tinby, parish of Obley, north-west of Yeoval. Wilga Creek, 6 miles south of Goodrich. 18 to 24 miles south-west of Wellington. R. 86/107, 87/57, 01/17, 11/20. *Gold.*

J.E.C. M.R. No. 6, 03/369, 370, 372, 373; E.F.P. 80/243; R. 86/170, 97/63, 08/47, 09,/18, 12/49. *Copper, Gold.*

Lower Tinby, parish of Obley. J.E.C. 97/171; M.R. No. 15, 12/86; E.F.P. M.R. p. 303; Assay, 96/143. *Cupro, Sheelite.*

Hyandra Creek, parish of Hyandra, 20 miles south-west of Yeoval. *Gold.*

Goodrich or Buckinbah and Gordon, parish of Bolderodgery, 4½ miles south-west of Yeoval. E.C.A. M.R. No. 24, 16/89. *Molybdenite.*

YEO YEO. [*See* Cootamundra.]

YERRANDERIE, late The Peaks. Basin Creek, Tomalli River, Upper Burragorang, parish of The Peaks, county of Westmoreland, 26 miles north-west of Mittagong. E.F.P. 94/104, 99/162, 03/176, 14/187; M.R. p. 118; J.B.J. 01/165, 02/128, 03/130; C. O. G. Larcombe Trans. Aust. Engineers, Vol. II, 1906; J.E.C. 16/193; R. 85/72, 97/191, 98/68, 99/64, 00/52, 01/51, 02/46, 74, 03/44, 04/43, 05/20, 41, 77; 06/41, 85, 07/46, 08/41, 09/42, 10/42, 11/46, 86, 12/43, 13/45, 86, 14/25, 47, 85, 15/22, 44, 84, 16/43, 81, 17/37, 18/35, 79; Bores 12/73, 13/76, 101. *Silver, Lead, Gold.*

Tin Kettle Creek, parish of Colong. E.F.P. 94/104; R. 98/38. *Silver.*

Colong Caves. [*See* Jenolan.]

YESSABAH CAVES. [*See* Kempsey.]

Digitized by Google

YETHOLME. [*See* Tarana.]

Mount Tennyson, parish of Yetholme, Gemalla, Eusdale Creek, parish of Eusdale, south-east of Mount Tennyson, Mount Tarana, north-west of Tarana, county of Roxburgh. E.C.A. and J.E.C. 15/177; E.C.A. M.R. No. 24, 16/170–189, 17/161; G.W.C. 17/165; R. 14/65, 15/60, 16/59, 17/53, 18/56, 78. *Molybdenite.*

Dirty Swamp. Mines and Mineral Stat. of N.S.W., 75/92; J.E.C. M.R. No. 6, 08/269; .R. 76/74, 78/97, 16/81. *Copper, Gold.*

Parish of Melrose, 1 mile south-east of Brewongle. E.C.A. M.R. No. 24, 16/60, 73. *Molybdenite* (traces).

Green Swamp or Anthony's Creek, parish of Yetholme. M.R. No. 25, 19/325. *Limestone.*

YOUNG. Lambing Flat, Burrangong Creek, Wombat, Spring Creek, parish of Young, county of Monteagle. C.S.W. 76/153, 78/151; W.A. 90/266, E.F.P. M.R. p. 62; R. 75/42, 79, 86/63, 95/22, 04/18, 05/20, 07/16, 10/14, 11/14, 12/13, 15/13, 18/11. *Gold.*

Burrangong Creek. Dredge 01/36, 03/30, 06/26, 13/29. *Gold.*

Wombat, parish of Wilkie, county of Harden, south of Young. R. 95/22, 98/35. *Gold.*

Moppity, parish of Moppity, county of Harden, 6 miles south-east of Young. R. 94/25. *Gold.*

Scrub Yard or Woodstown. R. 79/101. *Gold.*
J.E.C. 97/150; M.R. No. 1, 1898. *Chromite.*

Murringo (Marengo), parish of Murringo, county of Monteagle, 13 miles east-north-east of Young. M.R. No. 25, 19/277. *Limestone.*

YOWAKA. [*See* Pambula.]

Yuba. Albert District. R. 98/101. *Copper.*

YULGILBAR. [*See* Lionsville.]

ZARRARI. [*See* Gunnedah.]

ZIG ZAG. [*See* Coal Index.]

Digitized by Google

LOCALITY INDEX.

PART II.

COAL AND SHALE.

For List of Collieries *see* Ann. Rep. Dep. of Mines, 1918, pp. 144, 145, 146.

For Assays *see* Coal Resources of N.S.W.; E. F. Pittman, 1912. Minerals of N.S.W.; A. Liversidge, 1888, p. 126; Tables published annually in the Ann. Rep. Dep. of Mines, commencing with the Report for 1875, which also supplies particulars of coal output prior to that year.

A.A. Company, Newcastle. T.W.E.D. Mem. G. 4, 07/65, 77, 113, &c.; Bore Mem. G. 4, 07/208–227, Sec. IV; Colliery Guardian, 1864, VII, p. 444; M.P. 82/127; M.P. 87/100, 102, 122; R. 76/141, 79/206, 207, 80/196, 86/119, 87/122, 89/184; Platt's Estate, 77/189, R. 79/207; A. 75/132, 78/18; C.R. 12/28.

Merewether Bore R. 02/83.

[*See* Stroud.]

Abberbrothock. [*See* Hinton.] Bore T.W.E.D. Mem. G. 4, 07/184.

Abbotsford. T.W.E.D. Mem. G. 4, 07/65, 77, 113, &c.

Aberdare Colliery. A. 05/164, 11/203; C. Res. 12/60, 64; T.W.E.D. Mem. G. 4, 07/159.

Aberdeen. Robinson's Hill. Lismore.

Northern State Coal Mine, parish of Russell, county of Durham. J.E.C. 14/194; R. 11/79, 12/73. [*See* Muswellbrook and Kayuga.]

Abermain Colliery. [*See* Cessnock.] T.W.E.D. Mem. G. 4, 07/108, 144, 148, &c. Bore R. 05/75, 09/75, 10/73, 185, 186, 16/73; A. 07/175; C. Res. 12/64, 65.

Kerosene Shale. Mem. G. 4, 07/162; A. 10/186.

Acacia Creek. [*See* Clarence Basin.]

Adamstown. [*See* New Lambton.] Mem. G. 4, 07/251.

Brickworks Colliery. Burwood Seam. C.R. 12/29.

Shortland Colliery. C.R. 12/52; Bore R. 83/188, 85/160.

Ællalong. [*See* Cessnock.] T.W.E.D. Mem. G. 4, 07/50, 51, 88, &c.; Bore 08/79; A. 10/186.

Airly. [*See* Capertee.] J.E.C. Mem. G. 3, 03/133, 156; Mem. G. 6, 08/214; T.W.E.D. Mem. G. 4, 07/332.

Albion Park. L.F.H. Mem. G. 7, 15/24.

Allison's Bores. [*See* Mullet Creek, Wallarah and Wyong.]

Alnwick. M.P. 1887, plate 17.

America Creek. Mount Kembla. E.F.P. M.R., p. 360; J.E.C. Mem. G. 3, 03/280; M.P. 82/6 *Kerosene Shale,*

Anna Bay. Bore T.W.E.D. Mem. G, 4, 1907, Sec. III; R. 90/157, 158; 1891, diag. 10.

Anvil Creek. Greta. T.W.E.D. 87/148; Mem. G. 4, 07/70, 138; M.P. 82/6, 126; M.P. 87/131, plate 16; R. 86/119; A. 75/18, 78/18, 93/37.

Digitized by Google

APPIN. Bore. L.F.H. G. 7, 15/400–2; R. 14/200.
APPLE TREE FLAT. [*See* Minmi.] Bore R. 85/163.
ARDGLEN. [*See* Doughboy Hollow.]
ASHFORD. T.W.E.D. 85/139; Mem. G. 1, 87/166; Mem. G. 4, 07/1, 124 &c., 354; E.F.P. Rec. V, pt. 1, 86/26; E.F.P. and T.W.E.D. Rec. VI, pt. 2, 99/77; Proc. Linn. Soc., N.S.W., VIII, 2nd series, 93/587. Proc. R. Soc., Vict., pt. 2, New series, 97/204; A. 84/28, 85/139, 95/52; Coke L.F.H. MR. 23, 16/64.
Fraser's Creek R. 01/148.
ASH ISLAND. Bore T.W.E.D. 89/228; Mem. G. 4, 07/81, 222, Sec. VI and XI; R. 88/220, 221; A. 89/32, 228.
ASHTON FIELDS COLLIERY. Thornton and Maitland. J.E.C. 16/205, A. 15/193.
AUSTINMER. [*See* Excelsior.] L.F.H. Mem. G. 7, 15/157; A. 14/215, 17/177.
AUSTRALIAN COKING AND BY-PRODUCTS Co. Islington, Newcastle. M.R. No. 23, 16/61.
AUSTRALIAN K.O. COMPANY. [*See* Genowlan, Joadja and Katoomba.]
AUSTRALASIA Co. Charlestown. R. 77/185.
AUSTRALASIAN or Cardiff Seam Mem. G. 4, 07/18, &c., 251. Distinct from Old Cardiff Co., which worked the Great Northern Seam.
AVONDALE. A. 95/52.
AWABA. Broken Back ranges. R. 82/95; A. 93/37, 94/47, 09/193, 10/185–186, 17/177. [*See* Mulbring.]

BAERAMI. Reubens Gully, Widdin Brook, parish of Caroora, county of Hunter. A. 04/153, 12/196; J.E.C. 18/155. *Kerosene Shale.*
BALGOWNIE COLLIERY. L.F.H. Mem. G. 7, 15/147.
BALLIMORE. [*See* Talbragar.] E.F.P. 90/143; W.A. 88/186; J.E.C. Mem. G6, 08/24, &c.; J.E.C. and M.M. 15/179; R. 82/43, 84/65, 85/57, 88/71. Bores R. 81/121, 82/133, 86/138, 87/188, 88/217; A. 15/193.
BALMAIN. [*See* Sydney Harbour Colliery.] E.F.P. 01/161.
BALMORAL. [*See* Hilltop.]
BARANGARY CREEK. L.F.H. Mem. G 7, 15/138.
BARBERS CREEK. [*See* Marulan.]
BARIGAN. J.E.C. Mem. G. 3, 03/154, 236; J.A.W. Papers. M. 98/10702; A. 88/36, 90/35, 02/40. *Kerosene Shale.*
Deruin Creek. J.E.C. Mem. G. 6, 08/89.
BARRABA. A. 08/177. *Kerosene Shale.*
BATHGATE. Wallerawang. [*See* Marangaroo.]
BEGA. A. 94/48. *Kerosene Shale.*
BELFORD. P.T.H. 91/264; T.W.E.D. Mem. G. 4, 07/69, Sec. IV.
BELLAMBI. [*See* South Bulli.] L.F.H. Mem. G. 7, 15/7, 151; C.R. 12/86; R. 85/119; M.R. 23/16/39. *Coke.*
BELLBIRD COLLIERY.
BELLEVUE COLLIERY. Lake Macquarie. Cardiff seam, R. 81/120, 82/126.
BELMONT. Fennels Bay. R. 90/190; C.R. 12/29.
BELMORE FALLS. L.F.H. 11/184; Mem. G 7, 15/138.
BEN BULLEN. J.E.C. Mem. G. 6, 08/63–245; A. 89/32, 93/30.
BERRIMA. C.S.W. 90/206; M.P. 87/170; R. 77/183, 80/203, 81/120, 127, 82/63, 83/139; A. 75/135, 78/16, 19, 81/21, 22; A. 83/27, 84/28, 86/34, 89/32; R. 81/21. *Kerosene Shale.*

Digitized by Google

Berry. L.F.H. Mem. G. 7, 15/301, 331.
Billy Brook Creek.
Bishops Bridge. T.W.E.D. 86/145, 147, 150; Mem. G. 4, 07/150, 303; A. 86/30, 150, 88/33. [*See* Deep Creek.]
Black Bob's Creek. [*See* Shoalhaven.]
Blackheath. J.E.C. Mem. G. 3, 03/217; A. 85/26, 93/39, 06/179.
Black Jack. [*See* Gunnedah.] R. 86/121, 89/189, 190.
Blackman's Flat. Near Mudgee road. J.E.C. Mem. G. 6, 08/181; R. 95/102.
Black Creek. West of Greta. T.W.E.D. Mem. G. 4, 07/69, 139, 195.
Black Hill. Stockrington. T.W.E.D. Mem. G. 4, 07/233, 240.
Black Mountain Railway Station. Pinch Creek, near Guyra. E.F.P 04/137. *Lignite.*
Blacktown. J.E.C. Mem. G. 6, 08/161.
Bloomfield Colliery. T.W.E.D. Mem. G. 4, 07/75, 217, Sec. V.
Blue Gum Creek. Minmi. T.W.E.D. Mem. G. 4, 07/233, 239. [*See* Seaham.]
Blue Gum Flat. [*See* Ourimbah.]
Bobundara Station. Cooma. A. 10/185. *Lignite.*
Boggabri. A. 17/177.
Boldon Colliery. Western Field. A. 11/208.
Bong Bong. C.S.W. Papers. M. 00/22184.
Boomi Creek. 28 miles north-west of Barraba, county of Murchison, A. 07/178. North-east corner of county of Buller. 14/215.
Borehole Seam. South of Collieries. T.W.E.D. Mem. G. 4, 07/308.
Botany. [*See* Holt Sutherland.] Bores 17/71.
Bottle Creek. Bonalbo. A. 11/203.
Bourke District. Corella Bore. A. 92/33, 34. *Lignite.*
Bouruda. North of Merimbula and 40 miles north of Bouruda. J.E.C. Mem. G. 3, 03/206. *Lignite.*
Bowenfels. C.S.W. 75/129; R. 1878 plates 41, 42; R. 81/127; A. 75/132, 78/19, 83/27; M.P. 62/136.
Bowral. C.S.W. 90/206; L.F.H. Mem. G. 7, 15/337.
Box Vale Colliery. Late Mittagong. R. 93/89.
Branxton. [*See* Leconfield.] C.S.W. 84/149; Bore R. 85/156.
Black Creek. T.W.E.D. 87/147; Mem. G. 4, 1907, Sec. IV.
Breakfast Creek. [*See* Penrith.]
Breeza. L.F.H. 13/183; R. 01/149, 151, 14/179; A. 13/189, 15/193.
Brickfield Hill Colliery. Waratah. R. 84/130; Tighe's Hill, Pride of Ferndale, R. 85/119.
Bright Mount. [*See* Pokolbin.]
Broke's Nose. [*See* Cornimal.] R. 85/119.
Brogan's Creek. J.E.C. 17/157 (Vulcan Co.).
Broger's Creek. [*See* Jamberoo.] L.F.H. Mem. G. 7, 15/134.
Broken Back Range. [*See* Awaba.]
Broken Hill Proprietary. Port Waratah. M.R. No. 23, 16/52 *Coke.*
Broughton Head. J.E.C. Mem. G. 2, 03/283; L.F.H. Mem. G. 7, 15/301.
Budawang Range. Corang R. L.F.H. 12/184; R. 73/78. *Coal and Shale.*
Bullah Delah. 2½ miles south-east of village. *Coal.*

Digitized by Google

Bulli. T.W.E.D. Public Works Committee, 1897, p. 44; E.F.P., M.R. p. 316; L.F.H. Mem. G. 7, 15/160, 165; M.P. 81/141; R. 83/142, 91/201; M.R. No. 23, 16/41. *Coke.*
Bores L.F.H. Mem. G. 7, 15/161; R. 1891, diagram 13, 92/79, 81, 93/75; A. 05/164; M.P. 82/147; R. 88/147, Lower Seam.

Bulli North. [*See* North Illawarra.] C.S.W. 77/198; M.P. 87/143; R. 84/131; C.R. 12/91.

Bulli South. L.F.H. Mem. G 7, 15/151; C.R. 12/93, 94; R. 93/37.

Bulli Steam Colliery. Bulli Pass. L.F.H. Mem. G. 7, 15/160, 350.

Bullock Island. Wickham and Bullock Island Colliery.

Bundanoon. [*See* Erith and Ringwood.] J.E.C. and L.F.H. 15/178; Bore R. 86/185, 87/185; A. 84/29, 87/33, 90/33, 92/33, 12/196.

Bungaree Norah. Bore J.E.C. 07/165; A. 07/166, 178; C.R. 12/22.

Bungawalbyn. Richmond River. J.E.C. 08/168; A. 90/33, 91/31, 06/168, 07/178.

Burnett. Gragin Station. A. 84/29.

Burragorang. Tonalli River. Paddy's Peak, &c. J.E.C. Mem. G. 3, 03/169, 232.

Burragorang Mount. J.E.C. Mem. G. 6, 08/160, 185; E.F.P. 93/105; A. 90/33, 91/31, 94/47, 06/179, 10/186, 14/215; M.P. 1887, plate 1. [*See* Nattai River.]

Burwood Colliery. T.W.E.D. Mem. G. 4, 07/249, &c.; M.P. 87/117, 118; R. 76/136, 84/132, 133, 85/119, 88/138, 89/181, 188, 90/192; C.R. 12/30.

Burwood South. [*See* Dudley and Redhead.] R. 89/185, 90/191; A. 90/31.

Buttai. Bore T.W.E.D. Mem. G. 4, 07/204, 208, Sec. XI.; R. 89/145; A. 89/32, 90/33.

Byron. Parish of Champagne, County of Arrawatta.

Calderwood. Bryen's Colliery. L.F.H. Mem. G. 7, 15/108; A. 05/164.

Caledonian Colliery. T.W.E.D. Mem. G. 4, 07/159.

Calico Creek. Clarence Basin. A. 05/164, 17/177.

Cambewarra. C.S.W. 75/119; T.W.E.D. 90/249; Public Works Committee 1897, p. 44; J.E.C. Mem. G. 3, 03/283; J.B.J. Rec. VII, pt. 3, 03/103; R. 75/87.

Camden Haven. J.E.C. Rec. V., pt. 2, 1897.

Camp Creek. [See Metropolitan Company.] C.S.W. 84/151; L.F.H. Mem. G. 7, 15/183, 198, 406; C.R. 12/16.

Candelo. A. 93/37.

Capertee. District. J.E.C. Mem. G. 3, 03/115, &c.; Rec. IV, pt. 2, 94/39; Rec. VI, pt. 4, 00/283; T.W.E.D. Mem. G. 4, 07/332; E.F.P. M.R. p. 361; M.P. 87/180, plate 17; R. 83/28, 93/89, 95/103, 03/83; A. 83/27, 29, 84/31, 85/28, 88/35, 36, 89/33; A. 90/35, 91/32, 40, 92/38, 93/39, 94/48, 95/53.

Cardiff. [*See* Australasian, Lake Macquarie, S. Wallsend and Lymington.] T.W.E.D. Mem. G. 4, 02/243; M.P. 87/121–123; R. 82/125; A. 93/38, 05/164, 08/176; M.P. 82/129.

Carlo's Gap. McDonald's Hole, &c. J.E.C. Mem. G. 6, 08/205, 213, 214, 17/157; J.A.W. 97/183; M.P. 87/168, 169; R. 84/134; A. 84/31; Rec. VI, pt. 4, 00/277.

Digitized by Google

CASINO. Clarence Basin, Theresa Creek, 18 miles from Casino. A. 87/34, 90/34, 93/37; Rappville, A. 09/193.

CATARACT CREEK AND RESERVOIR. [*See* Berrima.] E.F.P. 04/135, 05/137.

CATHERINE HILL BAY. [*See* Lake Macquarie and Wallarah.] T.W.E.D. Mem. G. 4, 07/5, 7; M.P. 87/124, 125; A. 86/29; R. 81/123.

CEDAR CREEK. [*See* Pokolbin.]

CESSNOCK. T.W.E.D. Mem. G. 4, 07/49, &c.; Sec. II, VIII, and X; R., 90/155 1891, Diag. 7; P.T.H. 91/262; Bore S.A. Government; R. 08/77.

[*See* Ællalong and Abermain.]

CHARLESTOWN. [*See* Snakes Creek.]

CHATSWORTH. Clarence Basin.

CHIMNEY STACK. Capertee.

CHOUTA BAY. 42 miles north of Cape Howe. E.F.P. M.R. p. 310. *Lignite.*

CHRISTMAS CREEK. R. 1878, Sec. 39.

CLANDULLA. Capertee district. A. 08/177. *Kerosene Shale.*

CLARENCE COAL BASIN. T.W.E.D. 91/220, 221; J.E.C. 05/144, 08/168; Rec. VI pt. 4, 00/283; G.A.S. 95/173; M.P. 82/130; A. 92/34; Mylnes Gap, C.S.W. 89/203, 204; A. 89/32; Farquhar's Creek, Armidale Road, E.F.P. 80/244, 246; M.R. p. 310; A. 07/178, 09/193. Killarney and Mount Wilson, E.F.P. 08/164. Pine Brush, Shark Creek, Maclean, E.C.A. 08/167; 12 miles north of Rivertree, A. 91/36.

[*See* Boomi Creek, Bungawalbyn, Calico Creek, Casino, Copmanhurst, Coraki, Grafton, Killarney, Lismore, Moonan, Nimbin, Swan Bay, Pulganbar, Richmond, Tyalgum, Rocky Mouth, Tweed River, Wardell, Woodford Island, and Woolgoolga.

CLARENCE SIDING. Head of Dargan's Creek, alongside G.W. Railway. 1½ miles from Clarence Station. Bore J.E.C. Mem. G. 6, 08/163; R. 85/155, 86/183, 87/187; A. 85/26.

[*See* Edgecombe.]

CLIFTON. L.F.H. Mem. G. 7, 15/167; Rec. VI, pt. 4, 00/272; R. 84/139; A. 89/32, 92/33, 95/52; C.R. 12/94.

CLYDE COAL MEASURE. C.S.W. 85/131; J.E.C. Mem. G3, 03/284; J.B.J. Rec. VIII, pt. 2, 1900; E.F.P. M.R., p. 314; T.W.E.D. 90/250; L.F.H. 12/181; Mem. G. 7, 15/43, &c.; A. 85/26, 27, 28, 132, 10/186, 12/186, 13/189.

CLWYDD, VALE OF. C.S.W. 75/116.

COAL CREEK. [*See* Stroud.]

COAL CLIFF. E.F.P. M.R., p. 308; L.F.H. Mem. G. 7, 15/170; M.P. 82/148; M.P. 87/145; Plates 6, 17, 20; R. 77/183, 79/209; C.R. 12/87

COALDALE. [*See* Clarence Coal Basin.]

COAL POINT. Lake Macquarie. Toronto Bore, 84/181.

COCKLE CREEK. Lake Macquarie. Teralba. A. 85/26, 08/176; Bore, 84/183; Tunnel, 89/186.

[*See* Young, Wallsend.]

COCO. Capertee. J.E.C. M.R. 93, 03/133.

COFF'S HARBOUR. A. 89/33.

COLLEY CREEK. Liverpool Plains. Rec. VI, pt. 4, 00/295. *Kerosene Shale.*

COLLINS' COLLIERY. Exeter. C.R. 12/88.

Digitized by Google

COLEDALE. L.F.H. Mem. G. 7, 15/154; M.R. No. 23, 16/44. *Coke.*

COLO VALE. Mittagong. R. 84/172, 177, 178; A. 08/176.

COLO GATES. C.S.W. 82/144; R. 85/161.

COLO RIVER. [*See* Capertee.]

COLONG GAP. J.E.C. Mem. G. 6, 08/188.

COMMONWEALTH COLLIERY. Lidsdale J.E.C. Mem. G. 6, 08/209; C.R. 12/77.

COMMONWEALTH OIL CORPORATION. J.E.C. Mem. G. 6, 08/223, 251; R. 05/33. [*See* Wolgan.]

COMMONWEALTH TUNNEL. Cumber Melon. J.E.C. Mem. G. 6, 08/216.

CONDAMINE. [*See* Flagstone.]

CONJOLA and Little Forest. J.B.J. and L.F.H. Rec. VIII, pt. 2, 1905; L.F.H. Mem. G. 7, 15/252; R. 82/27; A. 86/29.

COOLANGATTA. L.F.H. Mem. G. 7, 15/226.

COOLATAI STATION. 25 miles north-north-east of Warialda.

COONABARABRAN. Proc. Linn. Soc., N.S.W., 1903, pt. 3, p. 586; R. 99/43.

COONAMBLE. North-west corner of Tunderbrine Run. 9 in. coal at 185 feet.

CO-OPERATIVE COLLIERY. [*See* Catherine Hill Bay and Plattsburg.] R. 76/139.

COORABIN. Parish of Goonambil, county of Urana. J.E.C. 16/198. *Brown Coal.*

COORUMBUNG. T.W.E.D. Mem. G. 4, 07/202.

COOYAL or Reedy Creek. Cudgegong River. C.S.W. 86/138.

COPMANHURST. A. 89/32.

CORAKI. [*See* Moonenbar.] T.W.E.D. 91/220; A. 90/33, 91/32, 34.

CORANG RIVER. L.F.H. 04/146.

CORDEAUX RIVER. L.F.H. Mem. G. 7, 15/283, 289.

CORRIMAL. Corrimal and Balgownie Colliery and Broker's Nose. L.F.H. Mem. G. 7, 15/10, 149; M.P. 87/141; R. 84/138, 85/119; C.R. 12/88; M.R. No. 23, 16/37. *Coke.*

COTTAGE ROCK. Capertee.

COX'S SIDING. [*See* Rawdon.]

CREMORNE. [*See* Sydney Harbour Colliery. T.W.E.D. 93/69, 71; E.F.P. 92/110, 93/69; M.R. p. 318; E.F.P. and T.W.E.D. Rec. IV, pt. 1, 1894; Jour. Roy. Soc., N.S.W., XXVII, 93/443; L.F.H. Mem. G. 7, 15/167, 205; C.R. 12/17; R. 90/163; 91/152; diag. 2, 92/77; diag. 2, 93/102; A. 91/32, 33, 275, 93/37, 70.

CROOBYAR CREEK. L.F.H. Mem. G. 7, 15/317.

CROWN RIDGE. Capertee. R. 95/103.

CUDGEGONG. A. 91/32.

CULLEN BULLEN. [*See* Portland.] Great Western Colliery, &c. J.E.C. Mem. G. 6, 08/181, 208; R. 88/151, 188, 89/189; A. 88/34, 151; 89/32, 90/33, 06/176, 11/203; C.R. 12/78.

CUMBER MELON. Capertee. [*See* Mornington.] C.S.W. and T.W.E.D. 91/213, 215; J.E.C. 04/142; Mem. G. 6, 08/215, 216; Mem. G. 3, 03/116, 119; A. 10/185.

CUNDLE. A. 93/37. *Brown Coal.*

CURLEWIS. [*See* Gunnedah.] G.A.S. 90/270; R. 89/189; A. 89/32, 90/34, 271, 91/33; C.R. 12/31.

CURROWAN CREEK. L.F.H. Mem. G. 7, 15/319.

Digitized by Google

DALWOOD. 3 miles north of Greta. C.S.W. 84/151.

DAPTO. [*See* Wongawilli.] T.W.E.D. and E.F.P. P.W. Committee, 97/45, 137; M.P. 87/147; R. 84/131, 137, 87/131, 88/148, 90/255; A. 17/177.

DARGAN'S CREEK. [*See* Clarence.]

DARK CREEK. Newcastle. Wallsend. Rouse Hill. Waratah.

DEEP CREEK. [*See* Bishop's Bridge.] Silkstone Mine. [*See* Abermain.] T.W.E.D. 86/145, 150, 87/148, 88/168, 89/209; Papers, M. 88/20896.

DEEPWATER. A. 91/40 *Kerosene Shale.*

DELUNGRA. Parish of Burnett, county of Burnett. 3 miles north-west of Delungra. 5½ inches coal.

DEMPSEY ISLAND. Bore T.W.E.D. Mem. G. 4, 07/208, 227; R. 84/182, 85/166.

DENT'S CREEK. [*See* Holt-Sutherland.]

DENMAN. J.E.C. 03/125.

DENTON PARK. T.W.E.D. Mem. G. 4, 07/66, 178, 296.

DERUIN CREEK. [*See* Barigan.] J.E.C. Mem. G. 6, 08/89.

DORA CREEK. Bore T.W.E.D. 88/166; Mem. G. 4, 07/82; Sec. VI, R. 83/170, 186; A. 83/26.

DOUGHBOY HOLLOW. [*See* Murrurundi.] Bore T.W.E.D. 92/167; R. 92/75, 159; A. 90/35, 91/40, 92/38, 159–162, 07/180, 13/39. *Kerosene Shale.*

DUBBO. [*See* Ballimore and Talbragar.] C.S.W. 80/239; E.F.P. 80/243; Rec. VI, pt. 4, 00/273; R. 91/32; 08/176, 14/215.

DUCKENFIELD. R. 76/135; M.P. 87/111; C.R. 12/32.

DUCKHOLE. Bores T.W.E.D. Mem. G. 4, 01/55. Sec. III and XI.

DUDLEY. [*See* S. Burwood.] A. 93/38; C.R. 12/33.

DUNGAREE. A. 88/36; 89/33; K. Shale.

DUNKIRK. [*See* New Lambton.]

EAST GRETA. [*See* Greta.]

EBBW MAIN. (Greta.) C.R. 12/68, 69.

EBBW VALE. (Adamstown.) C.R. 12/34.

EDGECOMBE MT. Lithgow Bore. R. 11/76.

ELERMORE VALE. C.R. 12/34.

ELLALONG. [*See* Ællalong.]

ELLESMERE. [*See* Rix's Creek.]

ELONG. L.J.J. 18/164; A. 18/169.

ENDRICK RIVER. L.F.H. Mem. G. 7, 15/312.

ERITH. Bundanoon. R. 81/120, 125; M.P. 87/171.

ESKBANK. [*See* Lithgow] M.P. 87/161; A. 75/133, 78/19; M.P. 82/139; M.R. No. 23, 16/65.

EUI CREEK. [*See* Tangorin.]

EUROKA CREEK. [*See* Penrith.]

EVANS LOOKOUT. [*See* Blackheath.] J.E.C., Mem., G. 6, 08/158, 174; A. 05/164.

EXCELSIOR COLLIERY. Thirroul and Austinmer. L.F.H., Mem., G. 7, 15/157, A. 05/164, 12/196, 13/189, 14/215; C.R. 12/89.

EXETER. Proposed Federal Colliery. J.E.C. and L.F.H., 15/177; A. 69/193

Digitized by Google

FARLEY. [*See* Denton Park.] Font Hill. Homeville. Stony Creek, &c. T.W.E.D. Mem. G. 4, 1907, Sec. IV.

FARQUHAR'S CREEK. [*See* Clarence Basin.]

FASSIFERN. [*See* L.T. Creek and Northumberland Colliery.] T.W.E.D. Mem. G. 4, 07/244; R. 87/121,125, 88/142; Bore Trummer's Pit; T.W.E.D. 91/245; Mem. G. 4, 1907, Sec. VII; R. 88/216, 89/147, 151; A. 89/32, 13/189.

FEDERAL COKE WORKS, Wollongong. M.R. No. 23, 16/31.

FENNEL BAY. Lake Macquarie. [*See* Belmont and S. Stockton.]

FERN VALLEY. Lambton. R. 89/182, 188.

FERNDALE. [*See* Tighe's Hill.] T.W.E.D. Mem. G. 4, 07/286. Parliamentary paper, Roy. Comm. on Collieries, 1885–86, third report; also reports on accidents at Ferndale, pp. 1885–86; M.P. 87/112; R. 77/186, 80/206, 83/136, 87/124; M.P. 82/130; Peppertown, R. 80/196.

FITZROY. [*See* Mittagong and Nattai River.] C.S.W. 82/142, 90/206; T.W.E.D. 88/171; Rec. VI, pt. 4, 00/278, 306; R. 84/78.

FITZROY FALLS. L.F.H. Mem. G. 7, 15/137.

FLAGGY CREEK. [*See* Redhead and Waratah.] Bore 80/206, 207, 81/121, 122, 125.

FLAGSTONE CREEK. Condamine. A. 07/178.

FOLLY COLLIERY. [*See* Lidsdale and Waratah.] A. 11/203; C.R. 12/77.

FONT HILL. [*See* S. Greta, Homeville and Stony Creek.] R. 81/120, 83/136; M.P. 87/130; A. 08/176, 04/139. *Kerosene Shale.*

FOREST REEFS. E.F.P. M.R. p. 310. *Lignite.*

FOUR MILE CREEK. [*See* Rathluba, Thornley and Tomago.] T.W.E.D. 86/148; Mem. G. 4, 07/206; M.P. 1887, plate 17; R. 80/197, 199.

FRASER'S CREEK. [*See* Ashford.]

FULLERTON COVE. Bore T.W.E.D. 89/210; Mem. G. 4, 07/56; R. 83/170, 195, 87/179, 183. [*See* Stockton.]

GARDINER'S CREEK. Otford.

GARRETT'S COAL SEAM. [*See* Newcastle-Stockton, Raymond Terrace, Salt Ash Creek and Stroud.]

GARTLEE. Teralba. R. 89/182.

GENOWLAN. Capertee. J.E.C. Mem. G. 3, 03/25, &c., 156; R. 92/38. *Kerosene Shale.*

GERRINGONG. L.F.H. Rec. VIII, pt. 2, 06/2; Mem. G. 7, 15/10.

GEURIE. Maryvale. R. 90/193; A. 89/32, 91/33.

GINDANTHERIE. A. 94/48. *Kerosene Shale.*

GLADESVILLE. Bore 93/190, 191.

GLADSTONE. [*See* Wentworth Falls.] M.P. 87/156; R. 84/131,135; J.E.C. Mem. G. 6, 08/178; A. 87/34.

GLEBE. Merewether. C.R. 12/35. [*See* Newcastle.]

GLEN ALICE. Capertee.

GLEN. Katoomba.

GLENDONBROOK. T.W.E.D. 87/147; Mem. G. 4, 07/68, 274, 309; Sec. III.

GLEN OAK. [*See* Port Stephens and Seaham.] Bore 89/153.

GLEN ROCK. Burwood. T.W.E.D. Mem. G. 4, 07/33; C.R. 12/36.

GLOUCESTER. Between Stroud and Gloucester. T.W.E.D. 89/220. [*See* Stroud.]

GOONGAL. A. 94/48. *Kerosene Shale.*

Digitized by Google

GOVETT'S LEAP. A. 10/186.

GRAFTON. Bore. Sandstones and Shales, Coal streaks, 2205 to 2288 feet and 3,366 feet. At 3,419 feet, coal seam 7 feet, depth 3,698 feet. J.E.C. Mem. G. 3, 03/111–112; Bulletin of the Territory of Papua, Bulletin No. 1, 13/78; A. 88/33, 14/215; District R. 92/38. Fraser's Minc. A. 14/215. *Kerosene Shale.*

GREAT COBAR COLLIERY. Eskbank. C.R. 12/77; J.E.C. Mem. G. 6, 08/197; C.R. 12/77.

GREAT NORTHERN. (Seam worked at Gartlee, Rhondda, South Stockton, South Hetton, Morrisset, Catherine Hill Bay.) Pacific Colliery, T.W.E.D. Mem. G. 4, 07/3, 82, 254.

GREAT WESTERN. Cullen Bullen. A. 11/203; C.R. 12/78.

GRETA. C.S.W. 84/149; E.F.P. M.R. p. 314–361; T.W.E.D. Mem. G. 4, 07/66, 71, 135, &c., Sec. III and X; R. 75/56, 57, 76/138; M.P. 82/130, 134; M.P. 87/132, 133, plate 16; J.E.C. Mem. G. 3, 03/269, 274; Bores 18/74. [*See* Anvil Creek.] *Kerosene Shale.*

Central Greta. C.R. 12/66; Russell's Colliery, A. 75/130, 78/18.

East Greta. T.W.E.D. 90/225; Mem. G. 4, 07/75, 76, 150, 171, Sec. V; A. 90/34, 225, 93/37; C.R. 12/67,68.

Heddon Greta. T.W.E.D. 90/226; Mem. G. 4, 07/170, 172; Bore 09/73; R. 89/182; A. 93/38.

Stanford Greta. A. 90/228; Papers G.S. 01/583.

South Greta. [*See* Font Hill.]

T.W.E.D. 89/224; Mem. G. 4, 07/175, 324; J.E.C. 04/139; Mem. G. 6, 08/225; A. 03/141, 04/139, 12/196, 15/193, 16/221; C.R. 12/74; A. 07/180. *Kerosene Shale.*

West Greta. C.R. 12/75.

GROSE VALLEY. J.E.C. Mem. G. 3, 03/200; Mem. G. 6, 08/164, 173, &c.; R. 81/121, 124, 82/132; A. 83/26, 27, 06/179, 07/178, 09/193.

GROVE TOWN. Bebside Colliery, N. Lambton. R. 93/88.

GULGONG. C.S.W. 76/168, 172; E.F.P. M.R. p. 310. *Lignite.*
J.E.C., Mem. G. 3, 03/120, 258.

GUNNEDAH. Black Jack and Curlewis. T.W.E.D 86/151; G.A.S. 90/270; Rec. II, pt. 2, 90/66; E.F.P. 97/134, 135; J.E.C. M.R. G. 6, 08/52 186; A. 86/29, 151, 88/33, 89/32, 90/34, 273, 91/33, 95/52, 12/196; C.R. 12/36; A. 92/38, 95/53. *Kerosene Shale.*

GUYRA. [*See* Black Mountain.]

HAMILTON. A.A. Company Bore. R. 84/188, 191.

HARTLEY. Old Colliery. [*See* Thornton.]

HARTLEY VALE. N.S.W. Oil Company. J.E.C. Mem. G. 3, 172, 184; M.R. 87/158; R. 83/136, 85/131, 86/120; A. 88/36, 89/33, 06/25. *Kerosene Shale.*

Reedy Creek. J.E.C. Mem. G. 6, 08/165.

Litt'e Hartley. Mt. York. E.F.P. M.R., p. 361; R. 77/180.

New Hartley. Capertee. A. 93/39. *Kerosene Shale.*

HASSAN'S WALLS. J.E.C. M.R. No. 6, 08/165.

HAWKESBURY RIVER. Mangrove Creek Jarley Bore. R. 1878, plate 50.

Mullet Creek. R. 79/208.

Bore. J.B.J. 00/68; R. 08/75; 09/69; A. 10/185; C.R. 12/22.

HEATHCOTE. Mount Westmacott Bore. T.W.E.D. 87/154; Rec. IV, pt. 1, 1894; L.F.H. Mem. G. 7, 15/191, 198; R. 85/176; A. 84/29, 86/29, 30.

Digitized by Google

HEBBURN. Kurri Kurri. T.W.E.D. Mem. G. 4, 07/100, 162.
Bores 10/74, 11/76; C.R. 12/69, 70.
HEDDON GRETA. [*See* Greta.]
HELENSBURG. [*See* Metropolitan Colliery.]
HERMITAGE. Lithgow Valley. J.E.C. Mem. G. 6, 08/196; M.P. 87/163.
HETTON. R. 87/123, 88/140, 90/192, 16/168; A. 89/32, 93/38, 03/141; C.R. 12/37.
HETTON S. Coal Point, Lake Macquarie. T.W.E.D. Mem. G. 4, 07/259; R. 84/181, 94/91.
Kilaben Bay. R. 84/156.
HEXHAM. T.W.E.D. 88/173; R. 88/219; E.F.P. 98/148.
HILLSIDE. Newcastle. R. 91/194; C.R. 12/38.
HILLTOP. Rocky Waterholes. T.W.E.D. 88/169; A. 08/176, 10/185.
Balmoral Bore. R. 10/76.
HINTON. Abberbrothock Bore. T.W.E.D. Mem. G 4, 07/119, 183, 184.
HOLT SUTHERLAND. Botany and Dent's Creek. C.S.W. 87/139; T.W.E.D. 87/153; E.F.P. M.R., p. 317; Rec. IV, pt. 1, 1894; L.F.H. Mem. G. 7, 15/191, 198; C.R. 12/16; R. 79/ 209, 86/189, 83/170, 197; A. 86/117, 87/34.
HOMEVILLE. Font Hill. South Greta and Abram Collieries. T.W.E.D. 86/149, 87/149, 88/168; E.F.P. M.R. p. 314; A. 84/30, 86/30, 149, 87/39, 90/34, 04/139. *Kerosene Shale.*
HUMEWOOD. A. 95/52.
HUNTER RIVER COAL FIELD. T.W.E.D. 89/226; Mem. G. 4, 1907. Its relation to S. and W. coal. J.E.C. Mem. G. 6, 08/154.

ILFORD. Capertee District. J.E.C. Mem. G. 6, 08/177; A. 92/38, 08/177. *Kerosene Shale.*
ILLAWARRA and Lake. [*See* Dapto, Wongawilli, &c.] Leg. Ass. papers, 1890, 112, 341–90, p. 3.
T.W.E.D. 90/265. P.W. Committee, 1907, p. 143; E.F.P. M.R., p. 312.
M.P. 1887, plate 19; R. 83/141, 85/119, 91/196; Rec. VI, pt. 4, 00/275; L.F.H. G. 7, 15/3, 8, 263, 388; A. 91/33, 92/33.
North Illawarra Colliery. A. 89/32.
Illawarra Coke Co. Coal Cliff. M.R. No. 23, 16/48.
INVERELL. E.F.P. 08/164.
INVINCIBLE COLLIERY. Cullen Bullen. J.E.C. M.R. No. 6, 68/207; C.R. 12/78.
IRONBARK BRUSH. T.W.E.D. Mem. G. 4, 07/72, &c., 224, Sec. XI.
IRONDALE. Wallerawang, Co., Piper's Flat. J.E.C. Mem. G. 6, 08/181, 182, &c.; M.P. 87/165; C.R. 12/79.
IRONWORKS COLLIERY. Eskbank. J.E.C. Mem. G. 6, 08/197; A. 14/215, C.R. 12/79.
IRRAWANG. Stroud District. T.W.E.D. 89/222.
ISOLATED MOUNTAIN. J.E.C. Mem. G. 3, 1903, R. 83/136 *Kerosene Shale.*
IVANHOE. Portland. J.E.C. 01/163; Mem. G. 6, 08/203, 204; C.R. 12/80.

JAMBEROO. C.S.W. 75/119; Papers M. 00/22184; J.B.J. and L.F.H. Rec. VIII, pt. 1, 1905; M.P. 87/148, plates 12-20; L.F.H. Mem. G. 7, 15/112, 127.
JELLORE. Smith's Creek. T.W.E.D. and E.F.P., P.W. Committee 97/137; A. 81/22; E.F.P. and A.A.A. Papers, M. 01/14381.

Digitized by Google

JERRAWONGLA VALLEY. A. 16/220.
JERVIS BAY. T.W.E.D. P.W. Committee, 1897, p. 45. M.P. 87/149; L.F.H. 11/187, 12/181; Mem. G. 7, 15/262; R. 86/71; A. 89/32, 33.
JOADJA. Australian Kerosene Oil Co. C.S.W. 90/208; E.F.P. 90/108; M.R., p. 360; J.E.C. Mem. G. 3, 03/218; M.P. 82/148, 87/176, plate 15; L.F.H. 06/171; R. 77/180, 181, 84/30, 88/149, 03/78; Bores 88/208, 209, 89/142, 143, 150; A. 87/36, 88 34, 36, 89/32, 90/34, 35.
Wangaderry Creek. A. 83/27.
JORDAN'S CROSSING. Shoalhaven River. A. 78/18.

KANANGRA WALLS. Thurat Plateau. W.S.L. 89/252.
KANGAROO CREEK, RIVER, and Valley. C.S.W. 90/203; M.P. 1887, plate 17; L.F.H. 11/184; Mem. G. 7, 15/122; A. 12/196.
KANIMBLA. A. 07/178.
KATOOMBA. Gladstone, Isolated Mountain, Megalong, Ruined Castle, Mount Mouin, &c. J.E.C. Mem. G, 3, 03/171, 202; G 6, 08/154, 171–4; M.P. 82/140; M.P. 87/156, 178; R. 90/221; A. 84/ 29, 31; 89/32, 33, 91/40, 07/178, 180.
KAYUGA. [*See* Muswellbrook.] J.E.C. 08/167; R. 14/180; A. 08/176, 11/203; C.R. 12/38.
KEIRA, MOUNT. Osborne-Wallsend Company. M.P. 82/151; M.P. 87/128, plate 20; L.F.H. Mem. G. 7, 15/6, 142; A. 75/134, 78/19, 11/203.
KEMBLA, MOUNT. E.F.P. M.R., p. 361. T.W.E.D., P.W. Committee, 97/142, &c.; A.A.A. 02/98; L.F.H. 10/179, 11/185, 186; Mem. G. 7, 15/94, 97, 100, &c. Mines and Mineral Stat. 75/249; R. 75/5, 80/204, 88/148; M.P. 82/151, 87/145; A. 75/134, 78/19, 90/34, 10/186; C.R. 12/90
Includes Kembla Harbour and South Collieries.
Mount Lyell Coke, M.R. No. 23, 16/28.
KEROSENE VALE. [*See* Marangaroo.]
KIAMA. [*See* Jamberoo.] E.F.P. M.R. p. 315; J.B.J. Rec. VIII, pt. 1, 1905; T.W.E.D. Pub. Works Committee, 97/44.
KIANDRA. E.F.P. M.R. p. 310. *Lignite.*
KILCOY, Tomago. T.W.E.D. Mem. G. 4, 07/221; R. 81/127.
KILLARNEY, Clarence River Basin. A. 92/33, 08/166.
KILLINGWORTH, near Cockle Creek. T.W.E.D. Mem. G. 4, 07/91, 236, Sec. VII; C.R. 12/39.
KING'S TABLELAND. J.E.C. Mem. G. 6, 08/190.
KOWMUNG. [*See* Kanangra.]
KURRI KURRI. [*See* Hunter River Coalfield.]
KYUGA. [*See* Kayuga.]

LAKE ILLAWARRA. [*See* Illawarra.]
LAKE MACQUARIE. [*See* Macquarie.]
LAMBTON. T.W.E.D. Mem. G. 4, 07/21, 23, 243; R. 1,878, Plates 23, 24, 25, 28, 33, 34, 35, 43; M.P. 82/132; M.P. 87/107, plate 13; R. 83/136, 89/182; Bores R. 82/124, 86/190; C.R. 12/40, 45.
Dunkirk. R. 85/119. [*See* Scottish Australian Co.]
LA PEROUSE. A. 01/172.
LAWSON. A. 83/27.
LEADVILLE. A. 63/141.

† 45901—F

Digitized by Google

LECONFIELD. [*See* Greta.] C.S.W. 84/150; T.W.E.D. 87/147, 88/165; Mem. G. 4, 07; A. 84/29, 30, 88/33, 92/33, 93/37, 38, 18/169.
Branxton Bores. R. 84/150, 174–6, 85/156, 1901 Appendix, 18/137.
LIDSDALE. Near Cox River. J.E.C. M.R. No. 6, 08/209; R. 88/137, 93/88.
Bore near Wallerawang. R. 84/184, 185.
LIMEBURNERS, Tarean. T.W.E.D. Mem. G. 4, 07/187.
LINWOOD. R. 88/137.
LISMORE, Clarence Coal Basin. G.A.S. 95/173; A. 88/34.
LITHGOW. [*See* Eskbank, Edgecombe, Great Cobar, and Ironworks.] Coerwull and Hermitage Collieries, &c. C.S.W. 75/116, 91/215; J.E.C. 92/148; Mem. G. 6, 08/166, 167, 188, &c.
Section Seams. Lithgow to Sydney. Mem. G. 6, 08/160; M.P. 82/141; M.P. 87/162–4, plate 20; R. 76/134, 08/195; A. 75/133, 78/19, 92/34. *Coke.*
A. 91/39.
State Coal Mine. 17/59, 18/69.
LITTLE FOREST. [*See* Conjola.] Yatteyattah. A. 16/221. *Kerosene Shale.*
LIVERPOOL. Moorbank Bore. T.W.E.D. 91/244; Rec. IV, pt. 1, 1894; E.F.P. M.R. p. 317; L.F.H. Mem. G. 7, 15/195, 199; R. 89/136, 148, 90/138, 149; C.R. 12/16.
LOCHEND. R. 83/136; Bore R. 88/212, 89/144.
L.T. CREEK. [*See* Lake Macquarie and Fassifern.] Bore T.W.E.D. G. 4, 07/82, Sec. VI.; R. 83/170, 184.
LUE. A. 90/35. *Kerosene Shale.*
LYMINGTON. [*See* Cardiff S. and Young Wallsend.] J.E.C. 16/198; A. 16/221; C.R. 12/41.

MACLEAN. Clarence Basin. [*See* Pine Brush.] A. 92/34.
MACQUARIE LAKE. [*See* Bellevue, Belmont, Cardiff, Catherine Hill Bay, Coal Point, South Hetton, Morrisett, Munmorah, Pelican Flat, South Stockton, Toronto, South Wallsend, and Wallarah.] T.W.E.D. Mem. G. 4, 1907, Sec. 1; J.E.C. Mem. G. 3, 03/279; M.P. 1887, plate 15; R. 79/205.
Springview Colliery. R. 82/125; M.P. 87/121; A. 83/26, 84/29, 85/26, 86/29, 30, 89/32, 90/34, 10/185.
MACQUARIE MOUNT. Parish of Wongawilli. Bore 17/68. Coal at 790, 813, 851, 942 feet.
MACQUARIE RIVULET. L.F.H. Mem. G. 7, 15/112.
MADDOX PINCH. Cox River, Wallerawang. R. 95/102.
MAIN RIDGE COLLIERY. Piper's Flat. C.R. 12/81.
MAITLAND EAST. T.W.E.D. 86/147, 87/146, 150; Mem. G. 4, 07/350, Sec. IV, V; R. 84/179.
West Maitland. T.W.E.D. 90/229, Mem. G. 4, 07/66, 177, 305, &c., Sec. III, IV; R. 89/181, 90/193; A. 89/33.
[*See* Morpeth, Rathluba, Hunter River Coalfield.]
MAMMIE JOHNSTON CREEK. [*See* Stroud.]
MANGROVE CREEK. [*See* Hawkesbury.]
MANNING RIVER. Macdonald. A. 93/39. *Kerosene Shale.*
MARANGAROO. Bathgate, Kerosene Vale, Middle River, &c. J.E.C. Mem. G. 3, 03/244; M.P. 87/181, plate 22; A. 88/36, 92/38, 93/39.
MARSDON MOUNT. Rylstone. J.E.C. Mem. G. 3, 03/256.

Digitized by Google

MARULAN. Long Swamp, Barber's Creek. Tallong Bores R. 83/170, 192, 193; M.P. 82/149.

MARYLAND. Plattsburg. C.R. 12/41, 42.

MARYVALE. Wickham. R. 84/131, 132; M.P. 87/113.
[*See* Geurie.]

MATTHEWS' GAP. Pokolbin. T.W.E.D. Mem. G. 4, 07/141, 195.

MACQUARIE MOUNT. Albion Park. Central Illawarra Map.

MACLEAN. Clarence Basin. [*See* Woodford Island.]

MACDONALD'S HOLE. [*See* Carlos Gap.]

MACGUIRE'S CREEK. Narra Creek. C.S.W. 89/204.

MEBBIN ROCK. Clarence Basin. A. 17/177. [*See* Nimbin.]

MEDLOW. A. 15/164. 17/177. *Coke.*

MEGALONG. [*See* Katoomba.] T.W.E.D. 90/220; E.F.P. M.R. p. 362; J.E.C. Mem. G3, 03/204; Mem. G. 6, 08/180, 188, 189; R. 83/136, 90/220; A. 80/33, 90/34, 35, 222, 95/53, 17/177.

MELVILLE. North of Denton Park. T.W.E.D. Mem. G. 4, 07/179.

MEREWETHER. Bore R. 02/83.

MERIMBULA. A. 85 28, 10/185. *Lignite.*

METHVEN COLLIERY. J.E.C. Mem. G. 6, 08/200; C.R. 12/82.

METROPOLITAN COLLIERY. C.S.W. 84/151; E.F.P. M.R. p. 317–320, Rec. VI, pt. 1, 1894; L.F.H. Mem. G. 7, 15/183; J.C.H.M. 94/153, 154; R. 86/119, 88/146.
Main Shaft, 456 ft. above sea level. New Bore, 90 chains west of Main Shaft, 642 ft. above sea level. A. 88/146; 92/33; C.R. 12/89.

MIDDLE CREEK. Lithgow. M.P. 87/166, plate 22; R. 80/205. [*See* Mittagong.]

MILFIELD. T.W.E.D. Mem. G. 4, 07/141, 193.

MILPARINKA. A. 91/40. *Bituminous Shale.*

MILTHORPE. E.F.P. M.R. p. 310. *Lignite.*

MILTON. C.S.W. 85/131, 90/202. L.F.H. Mem. G. 7, 15/258. A. 90/34.

MILTON VALE. T.W.E.D. Mem. G. 4, 07/142.

MINIMBAH. [*See* Murinbin.]

MINMI. R. 1878, plate 31, 85/163; M.P. 82/132; A. 78/17; C.R. 12/29.

MITTAGONG. [*See* Box Vale, Colo Vale, Fitrzoy, Hill Top, Nattai and Stockyard Creek.] C.S.W. 82/141, 90/206, 91/215; M.P. 1887, plate 15; R. 83/136; T.W.E.D. Pub. Works Committee, 1897, p. 44; J.B.J. Mem. G. 2, 01/37; E.F.P. M.R. p. 315.
Middle Creek. C.S.W. 79/215.
Smith's Creek. C.S.W. 82/144.
Bore, W.A. 87/159; R. 87/190.
A. 78/17, 81/21, 82/142, 87/26, 87/35, 88/34, 89/32, 90/207. *Coal.*
A. 90/35, 91/34, 92/34. *Kerosene Shale.*

MONK WEARMOUTH. [*See* Minmi and Seaham Colliery.] Bores 85/167–9; R. 89/188.

MOONAN AND MOONENBAH. Clarence Basin, Swan Bay, Richmond River. T.W.E.D. 91/223; R. 91/131; A. 91/34, 226, 06/179.

MOONBI. District A. 94/48. *Kerosene Shale.*

MOORBANK. [*See* Liverpool.]

MOORE PARK. Bore C.S.W. 80/241; E.F.P. M.R. p. 317; Rec. IV, pt. 1, 1894; L.F.H. Mem. G. 7, 15/198.

MOREE. District A. 92/34, 17/177.

MORNA POINT. T.W.E.D. 89/ 227. *Kerosene Shale.*

Digitized by Google

MORNINGTON. J.E.C. Mem. G. 3, 03/249.

MORPETH. [*See* Lochend.] Eales Flat. J.E.C. Mem. G. 3, 03/273; T.W.E.D. Mem. G. 4, 07/77, 206, 210; M.P. 1887, plate 17.

MORRISSET. Lake Macquarie. T.W.E.D. Mem. G. 4, 07/260; C.R. 12/42; R. 82/121.

MORUNDUREY. Capertee. J.E.C. Mem. G. 3, 03/115, &c.

MOSCHETO ISLAND. Bore R. 83/196.

MOSS VALE. A. 88/34; 90/34.

MOUIN MOUNT. Katoomba. A. 07/178, 180.

MOUNTAIN ASH. Griffiths Hill, Lambton.

MOUNT LYELL. M.R. 23, 16/28. *Coke.*

MOUNT PLEASANT COLLIERY. L.F.H. G. 7, 15/145, 198; M.R. No. 23, 16/34. *Coke.*
C.R. 12/90.

MOUNT VICTORIA. [*See* Victoria.]

MOUNT WILSON. County of Buller. E.F.P. 08/165.

MUDGEE. District M.P. 82/142; A. 85/28, 87/35, 90/35, 92/38.
Coal and Kerosene Shale.

MULBRING. Vincent Trig. Station. A. 10/186.

MULLET CREEK. [*See* Hawkesbury.] R. 79/208*b*.

MUNMORAH LAKE. Boers 08/76, 09/71; A. 09/73, 10/185.

MURINBIN. Whittingham. Papers M. 09/7,592, 849.

MURRURUNDI. [*See* Doughboy Hollow and Colley Creek.] J.E.C. Mem. G. 3, 03/259; T.W.E.D. Mem. G. 4, 07/190; M.P. 87/6; A. 89/32, 92/34. 06/179, 07/180, 13/39.
British Australian Oil Co., Temi Mine. R. 13/39.

MUSWELLBROOK. T.W.E.D. 86/147; J.E.C. 08/166, 10/176, 14/194. Lease Branch papers 07/14,536; C.R. 12/71; A. 92/34, 08/166, 176, 10/185, 11/203, 18/169.
Piercefield. T.W.E.D. 86/147.

MYALL RANGE. Ællalong. T.W.E.D. Mem. G. 4, 07/193.

MYLNES GAP. Clarence Basin. C.S.W. 89/204.

NANDEWAR RANGE. Maules Creek. *Coal.*

NARRABEEN. Bore abandoned at 1,895 feet. C.S.W. 85/130, 148, 85/162, 87/137, 89/198; R. Etheridge Pal. Mem. No. 1, 1888; T.W.E.D. 90/233; E.F.P. M.R. p. 317; Rec. IV., pt. 1, 1894; J.E.C. Mem. G. 3, 03/116; L.F.H. Mem. G. 7, 15/199; R. 90/233.
Natural Gas.

NARRABRI. A. 84/30, 95/52, 08/177.

NATIONAL PARK. State Colliery. Bores L.F.H. Mem. G. 7, 15/403; R. 14/78, 15/73, 15/79.

NATTAI RIVER. C.S.W. 82/142; T.W.E.D. Public Works Committee 97/44; J.B.J. Mem. G. 2, 01/37; M.P. 82/152; M.P. 87, plate 11; A. 81/18, 82/143, 84/30, 92/34, 03/141.
[*See* Mittagong and Burragorang.]

NEATH COLLIERY. Cessnock T.W.E.D. Mem. G. 4, 07/160; A. 08/177; C.R. 12/72, 73.

NELLIE'S GLEN. [*See* Katoomba.]

NEW HARTLEY. Capertee. J.E.C. Mem. G. 3, 03/86, &c.

NERRIGA. R. 88/88. *Kerosene Shale.*

Digitized by Google

NEWCASTLE. E.F.P. M.R. p. 308, 312, 315; T.W.E.D. Mem. G. 4, 07/34, &c., 328; Sec. I and XII; M.P. 82/132; M.P. 87/116, plates 7, 8, 9, 11, 14; R. 86/120, 123; A. 83/28, C.R. 12/42, 43; Rec. VI, pt. 4, 00/272, 273, 277, 278, 282; New Winning Pit, R. 16/168; Workings under sea, E.F.P. 02/120; R. 16/141; subsidence of land 07/129; [*See* Nobbys]; Newcastle-Stockton, R. 90/194; T.W.E.D. 91/245 [*See* Raymond Terrace]; Newcastle-Wallsend, M.P. 87/109; R. 76/137.
NEW PARK. Rix's Creek.
NEW WINNING PIT. Newcastle.
NEWNES. [*See* Wolgan and Western State.]
NEW SOUTH WALES. Collieries and Coal Rec. VI, pt. 4, 00/270–285; Kerosene Shale Rec. VI, pt. 4, 00/293; J.E.C. Mem. G. 3, 1903. Percentages of ash and sulphur, R. 75/138; 77/29. N.S.W. Shale and Oil Co. [*See* Hartley, R. 84/130, 86/121, 122; M.P. 87/175.
NICHOLSON'S QUARRY. Maitland. T.W.E.D. Mem. G. 4, 07/180.
NIMBIN. Clarence Basin, Goolmangar and Calico Creeks, Mebbin Rock, &c. J.E.C. R. 05/144, 17/153, A. 10/185.
NOBBY'S. Newcastle Bore. Nobby's Seam. T.W.E.D. Mem. G. 4, 07/248; R. 1891, diagram 8.
NORAH. [*See* Bungaree Norah.]
NORTHERN AND GREAT NORTHERN COLLIERY. [*See* Pacific.] T.W.E.D. Mem. G. 4, 07/82; R. 87/125.
NORTHERN EXTENDED. C.R. 12/45.
NORTHERN COAL SEAMS. In relation to W. and S. seams. J.E.C. Mem. G. 6, 08/145; sections R. 78/181, &c.
NORTH SHORE. [See Cremorne and Narrabeen.]
NORTHUMBERLAND COLLIERY. [*See* L.T. Ck.] Oceanic Steam Co. T.W.E.D. Mem. G. 4, 07/93; R. 87/121; C.R. 12/46.
NOWRA. Wandra-Wandrian Bore. T.W.E.D. 90/244; R. 90/151; J.B.J. Rec. VIII, pt. 2, 1905; L.F.H. Mem. G. 7, 15/10, 43, &c.
NUNDLE. A. 91/40. *Kerosene Shale.*
NYMBOIDA. Clarence Basin. E.F.P. 80/246.

OAKLANDS. A. 16/221.
OAKEY PARK. Zig Zag. J.E.C. Mem. G. 6, 08/193, 194, 227; R. 87/121, 88/150, 06/33; Coke M.R. No. 23, 16/68; Bore 11/76.
OAK VALE. E. of Dulwich Colliery.
OCEAN VIEW. South Kembla. L.F.H. Mem. G. 7, 15/94; A. 87/35, 09/193.
OLD DOG AND RAT COLLIERY. E. of Lambton.
ORUNBIMBIE. Walcha. R. 83/89.
OSBORNE-WALLSEND. Balgownie. [*See* Mt. Keira C.R. 12/92.]
OTFORD. Bore C.S.W. 89/206; L.F.H. Mem. G. 7, 15/183; R. 00/115, 01/91; A. 89/32,207; Bore, parish of Bulga, 17/70.
OTTLEYS CREEK. 25 miles north-east of Warialda. A. 12/196.
OWENS. Balgownie Colliery. A. 12/93.
OURIMBAH. Bores. R. 88/145.

PACIFIC COLLIERY. Late Great Northern. T.W.E.D. Mem. G. 4, 07/81, 245, 301; C.R. 12/46, 47. Bore Quigley's Estate, 04/78.
PATERSON. Coal Basin. T.W.E.D. Mem. G. 4, 07/65, Sec. III.
PELAW MAIN COLLIERY. T.W.E.D. Mem. G. 4, 07/163, 167, 169; Sec. IX, A. 03/141, 05/114; C.R. 12/73.

Digitized by Google

PELICAN FLAT. Lake Macquarie.

PENRITH. Breakfast Creek. R. 84/180, 85/165.
Euroka Bore. T.W.E.D. 89/229; J.E.C. Mem. G. 6, 08/159, 160; A. 89/33. *Kerosene Shale.*
T.W.E.D., Jour. Roy. Soc., N.S.W., Vol. XXX, 1896, p. 59, 69, plate II.

PICTON. C.S.W. 91/212; A. 91/35, 06/179, 08/176; A. 89/33. *Kerosene Shale.*

PIERCEFIELD. 9 miles south-west of Muswellbrook, T.W.E.D. 86/147.

PIGEON HOUSE. T.W.E.D. Public Works Committee, 97/143.
L.F.H. 12/184; Mem. G. 7,. 15/258. [*See* Jamberoo.]

PINE BRUSH. Clarence Basin, Shark Creek. E.C.A. 08/167.

PIPER'S FLAT. [*See* Irondale and Ivanhoe.] J.E.C. M.R. No. 6, 08/204, 220; R. 82/133; C.R. 12/81.

PLATT'S ESTATE. [*See* A.A. Company.]

PLATTSBURG. Co-operative Collieries. M.P. 82/133; M.P. 87/110; C.R. 12/32; M.R. No. 23, 16/59. *Coke.*
Style's Grove, Papers, Misc. 12/9817, 561.

PLEASANT MOUNT. Wollongong. J.E.C. Mem. G. 6, 08/154; L.F.H. Mem. G. 7, 15/148; M.P. 82/152; M.P. 87/139; A. 91/34, 92/34; C.R. 91/39, 278; R. 92/52.

POKOLBIN. Cedar Creek, Mount Bright, Rothbury. T.W.E.D. Mem. G. 4, 07/140–141, 192, 195, Sec. VIII; Bore 17/68.

PORT HACKING. J.E.C. M.R. No. 6, 08/63.

PORTLAND. Black Diamond, Portland, Invincible, Commonwealth, Maddox Folly, Great Western, and Bulkeley's Collieries. J.E.C. Mem. G. 6, 08/183, &c.; C.R. 02/83.

PORT STEPHENS. [*See* Anna Bay, Stroud, and Raymond Terrace.] T.W.E.D. 87/149, 89/223; Mem. G. 4, 07/54, Sec. III.
J.E.C. Mem. G. 3, 03/276; Rec. VI, pt. 4, 00/282.
Morna Point, A. 86/31, 89/33, 227. *Kerosene Shale.*
Glen Oak, Seaham, Bass, and Yacaaba Bores, R. 89/153, 92/83, 1893, Diagram 3.

PORT WARATAH. [*See* Waratah.] Northern District and B.H. Prop. Coke Works, M.R. 23, 16/52.

PULGANBAR. Clarence Basin. E.F.P. 80/246.

PUMPINBELL CREEK. Clarence Basin, A. 17/177.

PYRMONT. J.E.C. Mem. G. 3, 03/114.

QUIGLEY'S ESTATE. Teralba. Bore, 01/78.

QUIRINDI. A. 07/180.

RADFORDSLEE. T.W.E.D. Mem. G. 4, 07/128.

RAPPVILLE. [*See* Casino.]

RATHLUBA. [*See* Four-Mile Creek.] T.W.E.D. 86/148, 149, 87/151, 89/228; Mem. G. 4, 07/206, 209, 212.; R. 77/184, 80/197; M.P. 87/127; C.R. 12/59.

RAVENSWORTH. Singleton Bores. C.S.W. 84/151; T.W.E.D. Mem. G. 4, 07/266; R. 89/154, 90/139, 165, 167.

RAWDON COLLIERY. [*See* Rylstone.]

Digitized by Google

RAYMOND TERRACE. [*See* Stroud.] T.W.E.D. 90/260, 91/245; Mem. G. 4, 07/44, 79, 113, 117; R. 88/137.

Richardson's Bores. T.W.E.D. Mem. G. 4, 07/80, 186; Sec. VI.

Newcastle-Stockton. R. 90/194; T.W.E.D. 91/245.

Garrett's Tunnel. Seven Mile. Saltash Creek. T.W.E.D. 91/246, 247.

REDHEAD. [*See* Scottish Australian Co.] T.W.E.D. Mem. G. 4, 07/31, 250; Bores R. 85/170, 86/186, 187, 87/186, 88/211, 89/149; M.P. 87/120; A. 89/32; Flaggy Creek Bores, R. 81/121, 122, 125; Ryhope, M.P. 1887, plate 10; R. 87/134.

REEDY CREEK. [*See* Hartley Vale.]

RHONDDA COLLIERY. Teralba. T.W.E.D. Mem. G. 4, 07/94, 257; R. 02/82, 83; C.R. 12/47.

RICHMOND RANGE. Casino to Tenterfield Road. Clarence Basin. A. 90/34.

RICHMOND RIVER. Clarence Basin.

Bungawalbyn Colliery, near Woodburn. J.E.C. 08/168; Papers P.B. 07/1782, 119; R. 09/169; A. 90/33, 91/31, 92/34, 06/168, 07/178.

RICHMOND VALE. Maitland. T.W.E.D. 89/207, 90/229; Mem. G. 4, 07/101, &c.; Sec. IX and X; R. 88/138.

RINGWOOD. Erith Seam. J.E.C. and L.F.H. 15/178; M.P. 87/172; R. 83/140; A. 84/30.

RIXON'S PASS. Wonona. L.F.H. Mem. G. 7, 15/166, 186.

RIX'S CREEK. T.W.E.D. Mem. G. 4, 07/68, 264, 309; Sec. III and IV; R. 80/195, 202, 203, 84/131, 85/119; A. 88/33; 03/141; C.R. 12/43, 44; M.P. 82/134; M.R. No. 23, 16/62. *Coke.*

[*See* Singleton.]

Rosedale Colliery. C.R. 12/48.

ROBERTSON. L.F.H. 11/182–4; Mem. G. 7, 15/139.

ROCKY MOUTH. Clarence Basin. Maclean. R. 85/164; A. 91/35, 92/34.

ROSE BAY. Bore E.F.P. M.R. p. 317; Rec. IV, pt. 1, 1894; L.F.H. Mem. G7, 15/199.

ROSEDALE COLLIERY. Nundah. Rix's Creek.

ROTHBURY. [*See* Pokolbin.] 80/137.

RUINED CASTLE. [*See* Katoomba.] R. 83/136, 139, 03/78.

RUSSELL'S COLLIERY. [*See* Greta.]

RYLSTONE. Rawdon Colliery Cox's Siding, &c. T.W.E.D. 91/214; J.E.C. Mem. G. 6, 08/217, 218; R. 87/126; A. 87/36, 90/34, 91/36, 06/179, 12/196. *Coal.*

A. 84/31, 86/31, 91/40, 92/38, 05/53. *Kerosene Shale.*
A. 17/177.

SADDLEBACK MOUNTAIN. L.F.H. Mem. G. 7, 15/133.

SALTASH CREEK. T.W.E.D. 91/246.

SANDGATE SEAMS. T.W.E.D. Mem. G. 4, 07/72, 234.

SCANLON'S TUNNEL. Maitland. T.W.E.D. Mem. G. 4, 07/181.

SCARBOROUGH. L.F.H. Mem. G. 7, 15/168.

SCONE. T.W.E.D. Mem. G. 4, 07/190; A. 90/35. *Kerosene Shale.*

SCOTTISH AUSTRALIAN CO. Lambton. R. 84/131, 141, 89,149.

Digitized by Google

SEAHAM. [*See* Minmi, Monk Wearmouth, and W. Wallsend.] T.W.E.D. Mem. G. 4, 07/104, 110, 238; R. 01/109, 03/77; A. 05/164.
Glen Oak Bore, no coal R. 89/153.

SHOALHAVEN RIVER. Near Jordon's Crossing. Black Bobs Creek. C.S.W. 79/214; A. 78/18.

SHORTLAND COLLIERY. Adamstown. C.R. 12/52.

SINGLETON. [*See* Rix's Creek.]
T.W.E.D. G. 4, 07/196; L.F.H. and M.M. R. 16/210; R. 87/121, 80/210; M.P. 87/134; A. 14/215; M.R. No. 23 16/62. *Coke.*

SNAKE CREEK. Bore Charlestown. R. 88/210.

SOUTH BULLI. [*See* Bulli.]

SOUTH CLIFTON. [*See* Clifton.]

SOUTH CREEK. Between Sydney and Penrith. E.F.P. M.R. p. 311.

SOUTHERN COAL FIELD. E.F.P. M.R. p. 315. L.F.H. Mem. G. 7, 1915; Southern Mine, near Kembla, L.F.H. Mem. G. 7, 15/93; R. 88/147; C.S.W. 90/206, Mittagong, &c.; Great Southern Mine, late Berrima. M.P. 82/170.

SPICER'S CREEK. Talbragar. W.A. 88/187; A. 88/33, 89/32, 18/169.

SPIRE. Parish of Gowang, county of Gowen, 1 mile from The Spire. *Brown Coal.*

STANWELL PARK. Bores.
L.F.H. Mem. G. 7, 15/176; R. 83/170, 181, 03/77.

STANFORD MERTHYR COLLIERY. T.W.E.D. Mem. G. 4, 07/101, 170, 172; C.R. 12/75; A. 03/141.

STATE COLLIERIES. [*See* Aberdeen.] National Park, Western Mine.

STOCKTON. R. 84/132, 88/139, 07/130, 143.
Bores R. 76/140, 1878, plates 45 and 46, 82/121, 83/195, 88/152, 90/193, 06/75, 07/74.
[*See* Newcastle-Stockton.]
North Stockton. Hexham Island. R. 88/139, 90/192; A. 91/35.
Stockton Borehole Colliery. Cockle Creek. C.R. 12/52, 53.
South Stockton. Fennel Bay. R. 94/90.

STOCKYARD CREEK. Mittagong. C.S.W. 82/144.

STONY CREEK. [*See* Farley.]
W. B. Clarke Trans. R.S. Vict. VI, 1865, p. 27; T.W.E.D. 86/147, 87/147; Rec. VI, pt. 4, 00/271; M.P. 87/129, 130; plates 16 and 17; R. 80/200.

STROUD. Stony Mammie Johnstone and Smith's Creeks. Ward R. T.W.E.D. 89/218, 226; Mem. G. 4, 07/44, 108, 277, 280; A. 92/34; 07/178; M.P. 1887, plates V and VI. A. 18/169.

STYLES GROVE. [*See* Plattsburg.]

SUGARLOAF. Mount Victoria. J.E.C. Mem. G. 3, 03/193.
Great and South Sugarloafs. Newcastle. T.W.E.D. Mem. G. 4, 07/243, 255.

SUMMER HILL COLLIERY. Wallsend. A. 91/38.

SUNDERLAND. E. Maitland. R. 87/121.

SWAN BAY. Clarence Basin. Richmond River. Richmond Hill and Coraki Co. Robinson's Hole. T.W.E.D. 91/221; R. 91/131; A. 91/37.

SWANSEA. Lake Macquarie. Mem. G. 4, 07/10, 19, &c.

Digitized by Google

SYDNEY HARBOUR COLLIERY. [*See* Cremorne.]
J.L.C. Rae E.F.P. T.W.E.D. Proc. R. Soc. N.S.W. XXXIII 99/207; Rae Eng. Assoc. N.S.W. 18th Oct. 1900; R. 00/154; 01/135; E.F.P. 01/161, 02/105, 04/113; J.L.C. Mem. G. 3, 03/114; Mem. G. 6, 08/156, 160; Section 07/154–161; A. 07/178; 10/185; C.R. 12/15, 95.

TALBRAGAR. [*See* Ballimore, Elong, and Spicer's Creek.] C.S.W. 80/239; E.F.P. 80/243; J.E.C. 15/179.

TALLONG (Barber's Creek). [*See* Marulan.]

TAMWORTH. Between Tamworth and Bendemeer. A. 85/27.

TANGORIN. T.W.E.D. Mem. G. 4, 07/188.

TANNYMOREL. [*See* Killarney.]

TARALGA. Rossville. A. 93/38, 95/52.

TAREE. District. A. 92/38. *Kerosene Shale.*

TARRO. Bore West of Hexham. R. 98/85, 106, 99/106, 03/76.

TAYAN PIC. Capertee. J.E.C. Mem. G. 6, 08/180.

TELLEGHERRI CREEK. Bore Watson' Wallis Creek. 180 feet, no coal. [*See* Anna Bay, Morna Point and Port Stephens.]

TERALBA. Garretts' Bores. R. 1878, Sections 53 and 54, Lake Macquarie. R. 83/170, 185; Quigley's Estate, T.W.E.D. Mem. G. 4, 07/254; R. 07/78, 79; C.S.W. 84/148; A. 78/17, 89/32, 91/37, 10/186; M.P. 82/135. Bore, 04/78.

TERMEIL. L.F.H. 11/182.

THIRROUL. [*See* Excelsior Colliery.]

THORNLEY. Four Mile Creek. [*See* Rathluba.] T.W.E.D. 86/148, 87/152; Mem. G. 4, 07/206, 217, 222; Sec. V., R. 89/182; M.P. 87/128, C.R. 12/58; A. 93/38.

THORNTON. Late Woodford. [*See* Ashtonfields and Iron Bark Brush.] T.W.E.D. 87/152; Mem. G. 4, 07/216; Secs. V and XI. Bore 08/78; M.P. 87/126; R. 87/150, 88/174.

TIGHE'S HILL. [*See* Ferndale.] R. 84/130, 131, 86/121.

TIABUNDAH MOUNT. Lake Macquarie.

TOMAGO. T.W.E.D. Mem. G. 4, 07/64 &c. Sec. XI. E.F.P. M.R. p. 313; C.R. 12/11, 58; A. 89/32; L.F.H. G. 7, 15/34, 213.

TONGARRA. T.W.E.D. and E.F.P. Public Works Committee 97/137; L.F.H. 05/152, 06/170, 07/171, 11/184; Mem. G. 7, 15/112; A. 05/164, 14/215.

TONGBONG MOUNTAIN. J.E.C. Mem. G. 6, 08/225.

TOORAWEANAH. T.W.E.D. Proc. Linn Soc., XXI, pt. 2. 96/263.

TORBANE. Capertee. J.E.C. Mem. G. 3, 03/135, &c. Mem G. 6, 08/214. Torbane Tunnel Colliery. C.R. 12/84.

TORONTO. Coal Point, Lake Macquarie. R. 81/195.

TURROWAN. E.F.P. 95/121.

TWEED RIVER. Clarence Basin. A. 91/38.

TYALGUM. Clarence Basin. J.E.C. 17/153.

ULAN. Goulburn River. J.E.C. Mem. G. 3, 03/257.

ULLADULLA. C.S.W. 85/131; A. 83/27, 29.

UMBIELLA. J.E.C. Mem. G. 3, 03/120, 136; A. 94/48.

UNANDERRA. [*See* Kiama and Jamberoo.]

URANA. [*See* Coorabin.]

URBENVILLE. Tabulam. A. 13/189.

Digitized by Google

VALE COLLIERY. Lithgow. J.E.C. Mem. G. 6, 08/227.

VALE OF CLWYDD. J.E.C. Mem. G. 6, 08/170, 199; M.P. 82/142; M.P. 87/159, Plan 20; A. 75/133, 78/19; C.R. 12/84.

VICTORIA MOUNT. Grose Valley, Victoria Falls, Sugarloaf, &c. J.E.C. Mem. G. 6, 08/173, 200; M.P. 87/157, 182, plate 22. Bore R. 08/80; A. 92/34, 03/141, 08/176, 11/203.

VICTORIAN STATE BORDER. Coast Kerosene Shale. A. 94/48.

VINCENT MOUNT. T.W.E.D. Mem. G. 4, 07/91, 242, 243.

WALCHA. A. 08/176. *Brown Coal.*

WALLANGRA. A. 89/32. *Lignite.*

WALLARAH. [*See* Catherine Hill Bay Co-operative Company, Lake Macquarie, Swansea and Wyong.] T.W.E.D. Mem. G. 4, 07/4, 9, 10, 260; R. 89/182, 186; Bore Amos 640 acres. R. 82/127; A. 94/47; C.R. 12/53.

WALLAYA. L.F.H. Mem. G. 7, 15/136.

WALLERAWANG. [*See* Irondale, Lidsdale, Pipers' Flat.] Rec. VI, pt. 4, 00/285, 305; R. 95/100, 102; A. 92/38, 93/39, 17/177; M.P. 82/143. Maddox's Pinch. R. 95/102.

WALLSEND. A. 75/131, 78/18; M.P. 82/135; C.R. 12/54; Coke. M.R. No. 23, 16/56.

Osborne Wallsend. [*See* Mount Keira.]

South Wallsend (Lymington), Lake Macquarie. R. 84/130, 88/138, 144, 95/101.

West Wallsend. [*See* Seaham.] R. 83/137, 138, 87/124, 01/109, 03/77; C.R. 12/56, 57.

Young Wallsend. T.W.E.D. Mem. G. 4, 07/235, 238, 245, 332; R. 86/120, 184, 87/124; R. 88/144; A. 89/33, 18/169; C.R. 12/57.

WANDRA WANDIAN or Wandandrian Bore. L.F.H. Mem. G. 7, 15/220, 253, 260. [*See* Nowra.]

WANGADERRY. [*See* Joadja.]

WARATAH. R. 1878, plates 1 to 52. M.P. 87/103, 105, Plates 12 and 13; M.P. 82/136; R. 75/129, 76/141, 78/18, 80/206, 207, 84/131, 86/121; 1891, Diag. 6, C.R. 12/54.

Port Waratah Bores. R. 85/157, 159.

Folly Bore. T.W.E.D. Mem. G. 4, 07/227.

WARD RIVER. [*See* Stroud] A. 18/169.

WARDELL Clarence Basin, Richmond River. C.S.W. 89/203; G.A.S. 95/173.

WARRAGAMBA. L.F.H. 14/207; R. 88/36; A. 18/169.

WARRUMBUNGLE. A. 87/36. Tertiary Coal. [See Tooraweanah.]

WATERFALL STATION. E.F.P. M.R., p. 317; C.R. 12/16.

WATIGAN CREEK. Ellalong. T.W.E.D. Mem. G. 4, 07/51, 281.

WENTWORTH FALLS. [See Gladstone.] J.E.C. Mem. G. 6, 08/176–190; A. 89/32, 33, 90/35.

WERRIS CREEK. J.E.C. 14/195.

WESTBROOK CREEK. C.S.W. 84/151; T.W.E.D. Mem. G. 4, 07/275.

WESTERN STATE COAL MINE. North of Lithgow. R. 11/76.

WESTERN COAL FIELD. J.E.C. Mem. G. 6, 08/154; R. 86/123; C.R. 12/9.

WESTMACOTT MOUNT. [*See* Heathcote.]

WHITBURN COLLIERY. Greta. C.R. 12/76.

Digitized by Google

WICKHAM AND BULLOCK ISLAND. M.P. 87/114.
WIDDIN BROOK. [*See* Baerami.]
WILGA. R. 14/179.
WILLIAMS RIVER. T.W.E.D. Mem. G. 4, 07/65, Sec. III.
WINGELLO. R. 87/33.
WINGEN. J.E.C. 14/195; Mem. G. 3, 03/136; T.W.E.D. Mem. G. 4, 07/98, 124, 190; R. 75/97, 79/205, 09/76; A. 06/179.
WINGECARRIBEE. A. 78/18, 90/34, 35, 10/186; M.P. 82/153.
WOLGAN. Capertee District. Commonwealth Oil Co., Newnes, &c. J.E.C. Mem. G. 3, 03/38, 42, &c., 177; Mem. G. 6, 08/158, &c.; M.P. 1887, plate 6; R. 05/33, 06/34, 07/37, 13/39; A. 06/179; C.R. 12/85 A. 85/28, 90/35. *Kerosene Shale.*
WOLLONGONG. [*See* Mount Keira.] Federal and Mount Pleasant Coke Works.
WONGAWILLI. L.F.H. Mem. G. 7, 15/102; C.R. 12/96; A. 17/177.
WONONA. L.F.H. 07/171, 11/182; Mem. G. 7, 15/166; A. 10/185.
WOODFORD. County of Cook. J.E.C. Mem. G. 6, 08/160, 167, 168; T.W.E.D. 89/229; A. 89/33. [*See* Thornton.]
WOODFORD ISLAND. Clarence Basin. R. 09/74.
WOOLOOWOOLANEY CREEK. Cobborah. A. 07/178.
WOOLGOOLGA. Clarence Basin. A. 07/178.
WYEE Bore. T.W.E.D. 91/245; Mem. G. 4, 07/84, Sec. VI; J.E.C. 07/165; R. 90/169, 1891, diag. 12.
WYONG. Allison's Bores. T.W.E.D. Mem. G. 4, 07/84, Sec. VI; J.E.C. 07/165; M.P. 87/135; R. 82/129, 83/187.

YACAABA. N. Entrance, Port Stephens. R. 92/83, 1893, diag. 3.
YARRANGUA CREEK. L.F.H. Mem. G. 7, 15/137; A. 93/34, 03/141.
YELLOW ROCK CREEK. [*See* Tongarra.]
YERRANDERIE. [*See* Colong Gap.] A. 06/179, 10/185.
YORK MOUNT. [*See* Hartley, N.S.W.] S. and O. Co. M.P. 1887, plate 22.

ZIG ZAG. [*See* Oaky Park.] J.E.C. Mem. G. 6, 08/189, 190; M.P. 87/160; R. 83/136, 139; A. 12/85.

Sydney: William Applegate Gullick, Government Printer.—1912.

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

J. E. CARNE, F.G.S., Government Geologist.

MINERAL RESOURCES.

No. 29.

THE GEOLOGY AND MINING DEVELOPMENTS OF THE ARDLETHAN TIN FIELD.

BY

L. F. HARPER, F.G.S.,

Geological Surveyor.

Issued under the direction of the Honorable J. C. L. Fitzpatrick, M.L.A., Minister for Mines.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1919.

[2s.]

† 71279

Digitized by Google

Science Library

TN
[illegible]
[illegible]
A2
[illegible]

Digitized by Google

The Geology and Mining Developments of the Ardlethan Tin Field.

CHAPTER 1.—Introduction and Previous References, History of the Field, Acknowledgments.

CHAPTER 2.—General and Detailed Geology.

CHAPTER 3.—The Nature and Probable Genesis of the Ore Bodies, with Suggestions as to Prospecting.

CHAPTER 4.—Past and Present Mining, Treatment Plants, Nature of Ore, Returns, and the Prospects of Obtaining an Adequate Supply of Sub-Artesian Water.

Digitized by Google

CHAPTER 1.

INTRODUCTION AND PREVIOUS REFERENCES.

The Ardlethan Tin Field has received much attention from the investing public, and has been the subject of at least three official reports, apart from the annual returns of the Mining Warden.

As this field had not been discovered at the time Mr. J. E. Carne, F.G.S., Government Geologist, compiled his work on "The Tin Mining Industry, and the Distribution of Tin Ores in New South Wales,"* no mention is made of it.

It is the intention in this work to correlate all the information available, and supplement the original reports in the light of a detailed geological examination, and also express an opinion as to the genesis of the ore bodies, and the best means of prospecting the same.

The future prospects of the field are commented upon, but it must be realised that many factors have to be considered and deductions proved, before it would be wise to dogmatise on the subject.

The present writer had an opportunity of visiting the field just after the presence of tin had been proved, and the following report was supplied in 1912†:—

Report on the Ardlethan Tin Field.

(L. F. Harper.)

"Ardlethan is a town on the Temora-Barellan railway line, 337 miles from Sydney, and the tin occurrence is from 2½ to 3 miles north-west of the town, in the parishes of Warri and Ramsay, county of Bourke.

The geological formation of the country immediately in the vicinity of Ardlethan is Devonian quartzites and silicified slates, largely overlain by deposits of soil.

Proceeding in a north-westerly direction, a change is soon noticeable, the soil becoming more sandy, and within 2 miles the Devonian beds give place to a granitic rock. This rock is very weathered, and it is only the more silicified portions which give rise to the low range of hills adjacent to which the tin was discovered.

The granite was originally an acid type, and secondary silicification has gone on to such an extent that the present surface exposures consist almost entirely of silica.

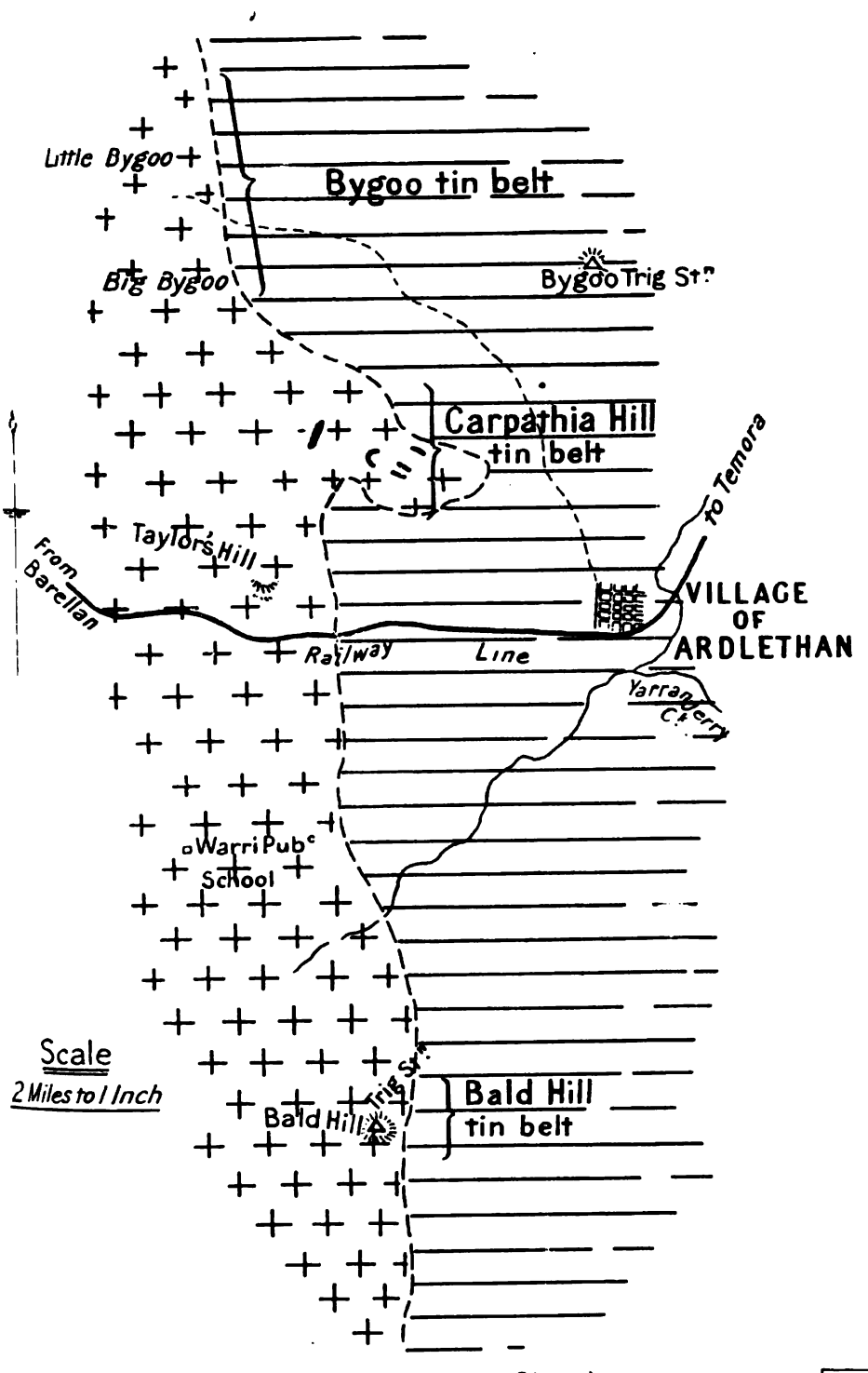
Crystallised quartz is very plentiful, and apparently the granite on cooling was sufficiently spongy to allow of a subsequent development of small quartz crystals, with veins and masses of quartz. Replacement by silica has also probably taken place to some extent.

The original prospector was J. J. Keogh, who discovered tin in this locality in January of the present year.

* Mineral Resources, No. 14, Department of Mines, Sydney, 1911.
† Annual Report, Department of Mines, 1912, p. 180.

Digitized by Google

LOCALITY PLAN



Devonian ? { Sandstones Quartzites Slates Conglomerates etc. } shown thus

Intrusive Granite " "

Intrusive Porphyry " "

Digitized by Google

Digitized by Google

Up to the present, thirty-five authorities to enter under the Mining on Private Property Act have been issued, and all the ground surrounding the original prospector's claim has been taken up, outside of which, however, practically no work has been done.

On Mr. Keogh's claim a few trenches and a shallow circular hole have been sunk, and the presence of tin proved over about a quarter of an acre of ground. The adjacent claim on the west is held by Mr. A. V. Crosby, and on its eastern boundary a shallow trench has been excavated which proved the presence of tin in small quantities, but the work done to date affords little evidence as to the extent of this occurrence.

The claims adjoining the above two on the north are held by Chamberlain and Stackpool. The area held by Mr. Chamberlain covers a junction between the granite and Devonian slate, which is seen near the south-west corner. A shallow cut was made near this corner on an outcrop of massive brown iron ore, with cassiterite, but granite is showing in the bottom of the cut.

A few chains further east, on the same claim, very siliceous granitic rock occurs, a sample from which was assayed and yielded metallic tin, 0·72 per cent.

On Mr. Stackpool's adjoining block a shallow trench has been dug on a similar type of rock, but no tin was noticed in the tip.

On Messrs. Jackson and McDonough's authority, which adjoins the prospector's at its north-east corner, a little prospecting has been done, and the following assay return was obtained from a sample taken in the north-east corner :—No tin detected; bismuth, 6·51 per cent.

This assay proves the presence of bismuth in this locality, but no defined reef has been found, and the bismuth is apparently contained in a small lens of quartz.

No other work has been done within the areas held, but a sample obtained from Mr. J. Hilley's authority, No. 227, in parish of Ramsay, about half a mile north-west of the prospector's claim, was assayed with the following result :—Metallic tin, 4·64 per cent. The prospector's claim covers 16 acres, and work is being carried on in the centre of the lease. A shallow hole is being sunk on a belt of silicified granite traversed by quartz veins, tinstone being unevenly distributed throughout.

Lumps of granular cassiterite (oxide of tin) varying in size up to 12 inches by 6 inches by 4 inches are found, and the quartz and granite are impregnated by specks, threads, and bunches of the same material. No crystallised tinstone was seen, it being all fine-grained and granular.

A "floor" in the granite is being followed down with the idea that it is a footwall of the "lode," but cassiterite is quite as abundant outside this as it is in the channel. The dip of the "floor" is from 50 to 53 degrees to the west.

A roughly-dressed sample taken across the bottom of the cut west from the floor, was assayed with the following result :—Metallic tin, 26·32 per cent.

A bulk sample of 2 tons of ore has been sent away for treatment, but no return is yet available.

For a distance of about 30 feet south of the foregoing excavation, shallow trenches have been sunk which prove the presence of tinstone. Continuing south for a distance of 8½ chains into Mr. H. V. Crosby's claim, traces of

Digitized by Google

tin have been found, and a sample obtained from the trench in the latter claim was assayed with the following result:—Metallic tin, less than 0·10 per cent.

In addition to the cassiterite, the following minerals were noted in the granite and quartz veins:—Chlorite, actinolite, crystals of tourmaline and quartz, limonite, hematite, arsenical stainings, native bismuth in minute specks, and a yellow powder, probably carbonate of bismuth.

Mode of Occurrence.—Owing to the small amount of prospecting work carried out it is somewhat difficult to form an accurate idea as to the mode of occurrence of the tin deposits.

The fact that prospects of tin have been found along a narrow belt striking north and south for 9 chains has led to the assumption that the tin is contained in a true fissure vein. The evidence available does not support this idea, however, for tin has not yet been proved throughout the entire length, but in a series of apparently disconnected patches, and no true channel has been proved.

The cassiterite occurs in the granite and in a series of quartz veins and patches, and is indiscriminately distributed along certain belts of granite.

In my opinion the occurrences are more in the nature of a series of disconnected pipes, the size of which have yet to be determined.

Twenty-four miles north-east of Ardlethan, at Buddigower, similar occurrences were worked some years ago, but are now abandoned.

At Mulyan, 44 miles north-north-west, I reported on a tin field (Annual Report, Department of Mines, 1907, p. 173) of the same nature, but very little tin was obtained there.

Prospects.—In view of the similarity between the Ardlethan deposits and those worked at the above localities, which proved to be of very limited extent, the outlook for permanency in the Ardlethan deposits is, in my opinion, not too promising.

The presence of a permanent cheap water supply is essential for the economic treatment of a low-grade tin proposition, which must of necessity be of large extent.

In view of the patchy nature of the tin contents in this granite, and the finely-divided state of the cassiterite, it will prove a difficult matter to economically win tin concentrates in this badly-watered area.

It is doubtful if the first requirement could be obtained, whilst it has yet to be proved that an extensive tin-bearing area, even of low grade ore, occurs in this neighbourhood.

As regards working the deposits, I would advise the prospectors to paddock out the tin-bearing areas, and handpick the ore sufficiently to produce a marketable standard."

At this stage it must be remembered that only a few shallow trenches had been excavated, and that the type of ore found on this tin field is not common. Even at the present time kernels of ironstone, absolutely devoid of any tin contents, are being unearthed in association with similar nodules, partly ironstone, but containing from 2 to 20 per cent. of tin.

A further factor in connection with the writer's first report, and the mines subsequently worked, is that the trenches then opened up remain to this day with no further work done upon them, whilst the present mine workings had not been touched at that stage.

Digitized by Google

At a later period in the same year, Mr. E. F. Pittman, A.R.S.M., at that time Government Geologist, visited the field, and furnished the following report*:—

Report on the Ardlethan Tin Lodes.

(E. F. Pittman).

"Although large quantities of tin have been found in New South Wales (over £9,000,000 worth has been won in the State up to the present time), the occurrence of tin-bearing lodes of a permanent character is comparatively rare, and for this reason the accounts which have found their way into the newspapers of the recently discovered stanniferous lodes at Ardlethan have excited a considerable amount of interest amongst mining men. These lodes are situated in the parish of Warri, country of Bourke, about 3½ miles to the north-west of Ardlethan, which is a small town situated 337 miles from Sydney on the railway line from Temora to Barellan.

About eleven or twelve years ago tin was discovered at Buddigower, 12 miles south-west of Wyalong, and about 20 miles north of the present find. The Buddigower lode was described by me in the Annual Report of the Department of Mines for 1891, page 158. Some good ore was obtained from these mines, that occurring on the surface being particularly rich, but the deposits did not prove to be permanently payable, and active operations were abandoned about six years later.

The town of Ardlethan is situated upon a belt of thin-bedded slates and sandstones of Silurian (?) age. These sediments dip to the west and south-west, and about a quarter of a mile to the east of the railway station they are overlain unconformably by thick-bedded coarse Devonian (?) sandstones which have a north-westerly strike, and which dip to the north-east at an angle of about 50 degrees.

About a mile or two to the westward of the township of Ardlethan, the Silurian slates give place to granite, and it is in the granite, close to its junction with the slates, that the tin-bearing lodes occur. It may be remarked in passing that in this respect the mode of occurrence of the Ardlethan lodes is similar to that of the Buddigower lodes previously referred to.

The Silurian slates are clearly the oldest rocks of the district, for the granite has intruded them, and near their junction the slates have been converted into micaceous schists by contact metamorphism.

In view of the fact that this is a populous district, it is very remarkable that the Ardlethan tin lodes should have remained undiscovered for so many years, for in some cases large masses of very heavy ore, consisting of cassiterite or tinstone encrusted with a considerable proportion of iron-oxide, have been found on the surface. Occasionally these masses have been found as much as 1 ton in weight, and have yielded from 40 to over 50 per cent. of metallic tin.

The lodes are situated in alienated land, and, consequently, it has been necessary for the miners to apply in the first instance to the Warden for authorities to enter and prospect, in virtue of which they can subsequently obtain leases from the Crown.

* Annual Report, Department of Mines, Sydney, 1912, pp. 173, 174.

Digitized by Google

The prospector's claim, or the first in which tin-ore was proved to occur, is now known as the "White Crystal" (portion P.M.L. 3, Keogh and party). The only work done on this claim at the time of my visit consisted of two trenches, and a shaft about 30 feet deep. In the latter the lode had a width of about 4 feet, dipping to the west at an angle of about 70 degrees. Some good ore was showing in the shaft, the cassiterite being distributed in grains through a gangue consisting of quartz with some felspar, and I was informed that 22 tons of ore had been sent away, but its value had not been ascertained, as the returns had not been received.

Adjoining the White Crystal is the Carpathia Tin Mining Company's land, surveyed as portion P.M.L. 4, of 16 acres. On the surface of this claim there was a large accumulation, about 20 feet wide, of ferruginous tin stone in boulders and masses ranging up to several feet in diameter, and containing from 40 to 55 per cent. of tin. The occurrence of this rich deposit of ore appears to have led some people to assume that it was the outcrop of a solid lode of tinstone 20 feet in width. In reality, however, it represented the accumulated ore resulting from the denudation, during past ages, of the upper portions of the lode. The gangue, after having been decomposed by atmospheric influences, had been washed away, while the tinstone, being heavy and comparatively indestructible, had remained where it had fallen, and formed a concentrated deposit of rich ore covering the lode. The first parcel of 10 tons of this ore despatched from the mine is said to have contained 40 per cent. of tin, and 34¾ tons realised, I am informed, over £2,500. After clearing away the loose surface ore, the lode immediately below it was found to be 12 feet wide. An excavation of 12 feet by 6 feet in horizontal dimensions had reached a depth of 12 feet at the time of my visit. It showed that at a depth of from 6 to 8 feet below the surface the lode was in three sections, viz. :— (1) 3 feet of fairly solid ore on the eastern or foot wall; (2) 2 ft. 6 in. of similar ore on the western or hanging wall, and between these there was (3) a mass 6 ft. 6 in. in width of decomposed gangue with occasional pieces of tin stone scattered through it. Representative samples of these three widths of ore were carefully taken, and were assayed in the laboratory of the Department of Mines. The results showed that the eastern 3 feet averaged 16·63 per cent. of tin; the western 2 ft. 6 in. averaged 17·02 per cent.; and the central 6 ft. 6 in. averaged 9·33 per cent. The average contents of the total width (12 feet) of the lode at this spot, therefore, works out at 12·75 per cent. of tin. This is, of course, an excellent result for such a width, considering the present extremely high price of tin, and if the lode be found to maintain anything like this width and value at a depth, there should be no difficulty in working it at a profit. In the meantime, however, it can only be said that the amount of development work done is so insignificant that it is impossible to express a definite opinion as to its future prospects. There were two other trenches across the lode in this claim, viz., one situated about 36 feet north of the last-mentioned excavation, and the other about 20 feet to the south of it, but the greatest depth attained in either of these was only about 4 feet, and they therefore afforded very little indication of how the lode may be expected to develop at a depth. Near the southern boundary of the claim, the outcrop of the lode, showing good ore, was visible, but its dimensions had not been proved, though apparently considerably less than in the excavation previously referred to. The course of the lode in this claim appears to be about north 26 deg. east, and it dips west 26 deg. north, at an angle of 48 degrees.

Digitized by Google

To the south of the Carpathia mine is Baker and party's claim (surveyed as portion P.M.L. 1), and known as the "Champion." The same lode that occurs in the Carpathia has been traced through this block, though here its course has changed more to the south-west. A trench has been cut along the course of the lode for about 50 yards in length, and from 2 to 5 feet deep, and from this, and from a small shaft, which at the time of my visit had reached a depth of 10 feet, about 16 tons of good ore had been extracted and bagged, though none of it had been sent away. In the 10 feet shatt, which was in hard granite, the lode appeared to be about 5 feet wide, while in the trenches it was not more than half that width on the average.

The Homeward Bound Mine, Clifford and party, surveyed as P.M.L. 2, is situated about a quarter of a mile to the west of the Carpathia, and it possesses the distinction of having the deepest shaft on the field, though this is only 40 feet. The lode in this mine has a strike of north 24 deg. east, and is nearly vertical. A shaft 8 feet deep, near the eastern end of the claim, shows the lode less than 1 foot in width, while in the main, or 40-feet shaft it was only 4 inches wide when first met with, but has widened out at the bottom, where it varies from 2 to 3 feet, and in the centre of the shaft bottom there is a "horse" or barren portion. I was informed that the following parcels of ore had been sent away from this mine:—

17 tons 17 cwt. of picked ore yielded 18 per cent. of tin.
5 tons of picked ore yielded 10–11 per cent. of tin.

There are 20 tons of "firsts" still at grass, and also 40 tons of "seconds" estimated by the owners to contain 7 per cent. of tin.

Wallis's claim (portion P.M.L. 6) is east of and adjoining the Homeward Bound. The lode at the surface is from 9 to 15 inches in width. Its course is north 20 deg. east, and it is nearly vertical. The amount of work done is insignificant—three potholes—the deepest 6 feet, having been sunk, and no ore has as yet been sent away. Another lode to the west of this, and approximately parallel with it, is owned by the same party. It is about the same width, and the deepest excavation upon it is about 4 feet.

Wallis and party have also another claim (portion P.M.L. 5) to the west of the Homeward Bound. A shaft 21 feet deep shows the lode to have the same bearings as in the Homeward Bound. Its width here varies from 2 to 3 feet, and it is nearly perpendicular. There were, at the time of my visit, about 10 or 15 tons of ore at grass, but none has been sent away, and consequently its value has not been ascertained.

The Wild Cherry claim (portion P.M.L. 9) is situated to the south-east of and adjoining the Homeward Bound Mine. A trench 12 feet deep and 30 feet long has been constructed along the course of the lode, which bears north and south, and dips to the east at an angle of 44 degrees. The lode is seen to vary in width, within the limits of this trench, from 6 inches to 3 feet 3 inches. A parcel of 20 tons of ore was sent away, and yielded 2½ tons of concentrates containing 61 per cent. of tin. This works out at about 7·6 per cent. of tin in the ore. There are about 7 or 8 tons of similar ore in bags at the mine.

There is quite a number of other claims in the vicinity; but in no case has sufficient work been done to justify a definite opinion as to the prospects of these lodes at a depth. It is clear, however, that the lodes are lenticular in form; in other words, they will be found to vary in width from an inch or two to several feet (or in exceptional cases even more), and the variation

Digitized by Google

in width will occur in a vertical as well in a horizontal direction. Moreover, there can be very little doubt that the tin-ore will be found to occur in *chutes*, as is the case in all other tin-bearing lodes, and that the productive *chutes* will be separated by more or less barren or unproductive portions. The country rock must also be expected to become harder as depth is attained, with a corresponding increase in the cost of mining, and, furthermore, it must not be forgotten that tin is at present at a phenomenally high price, at which it cannot be expected to remain permanently. It seems necessary to make these remarks in the public interest, because there seems to be a somewhat unjustifiable excitement on the Ardlethan Field at the present time. The claim-holders there have a tendency to "talk in thousands," and as a matter of fact claims have changed hands for very large sums of money, although I must confess that the amount of work performed upon them was totally inadequate to enable me to form a reliable estimate of their value. The most that one is justified in saying at the present time is that the surface indications are favourable for the occurrence of payable *chutes* of ore in some of these lodes, but a very considerable amount of work will require to be done before it can be confidently stated that any of them will be permanently payable.

Small quantities of bismuth and wolfram have been found associated with the tin. There is a decided similarity in the mode of occurrence of these tin-bearing lodes of Ardlethan and the auriferous lodes of Wyalong; both occur in granite close to its junction with Silurian slates, and both are distinctly lenticular in shape. It will be interesting to see whether the analogy is further borne out in the matter of the depth to which payable ore extends. Judging by the amount of ferric oxide present in the tin ore found at the surface, it is probable that below the water-level the tin will be found associated with much arsenical pyrites, as is so frequently the case with lodes of this character.

The Bygoo Lodes.—Another group of tin-bearing lodes has recently been found in granite rocks at a locality known as Bygoo, situated about 6 or 7 miles in a north-west direction from the town of Ardlethan. In their mode of occurrence the Bygoo lodes differ somewhat from those of Ardlethan. They are of considerable size, 10 to 20 feet in width, and have bold outcrops of quartz, in which the tin is disseminated in small grains, and in which it is also associated with a little wolfram and much tourmaline. The lodes appear to be more or less parallel to one another, the prevailing strike being about E. 20 deg. N. There has been very little work done upon these lodes, the deepest pothole being about 6 feet deep, and although 5 tons of picked ore have been sent away, no return has yet been received. It is evident that a considerable amount of concentrating will be necessary with the ore from these lodes, as the cassiterite which occurs as small crystals is more or less sparsely scattered through hard white quartz."

During 1915, Mr. J. R. Godfrey, Inspector of Mines, thoroughly investigated the various mines and prospecting shows. His report* deals essentially with the mode of occurrence of the ore bodies, and their actual assay value at the time of sampling same, with an expression of opinion as to the probable tonnage and value of the ore more or less actually in sight. Since that report was published, the tonnage and values has been greatly exceeded in many cases, but this is largely due to further development work

* Mineral Resources, No. 20, Geological Survey, New South Wales, Sydney, 1915.

Digitized by Google

having exposed ore bodies, the value and tonnage of which could not be considered in a Mining Engineer's report dealing with present and not potential makes of pay ore.

This report should prove of considerable interest to the student of ore bodies and be of great value to future prospectors and mining companies on this field.

It will be noticed on perusing the reports by Mr. Pittman and the present writer, that whilst the latter considered the sedimentary rocks in the neighbourhood of Ardlethan to be referable entirely to the Devonian period, Mr. Pittman expressed the opinion that both Devonian and Silurian sediments were represented. No fresh concrete evidence was obtained during the recent geological survey, so that the geological age of either beds still remains in doubt. The question is discussed in another part of this report, but the specific geological age of these beds has no importance with regard to the tin occurrences, and so may remain a matter of opinion until palæontological evidence is forthcoming.

HISTORY OF THE FIELD.

Mr. George James, Mining Warden, who in his administrative capacity has been intimately associated with the field since its opening, has supplied the following historical record.

The first application in connection with the Ardlethan Tin Field was made by Mr. J. J. Keogh, in May, 1912, and at the Warden's Court, on the 24th of May of that year, authorities to enter covering, among others, the Carpathia and White Crystal Mines were granted.

The mines, excepting those at Little Bygoo, are entirely on "private land" in the parishes of Warri and Ramsay, and county of Bourke, and the land on which tin was discovered, viz., part of portion 40, parish of Warri (now the Carpathia), was part of Warri Station.

Reports are common that numbers of people had from time to time remarked on the extreme weight of loose stones and boulders at this spot, and the owner of Warri Station, Mr. Wellman, claims to have known that tin ore existed; but if so he seems to have considered it not worth while bothering about, while no one else seems to have known of its identity or value. Mr. J. J. Keogh was, therefore, the first to send some of the ore contained in the loose boulders for assay, and followed it up by taking up and prospecting the ground, thereby becoming the discoverer and pioneer of the field.

The outcropping boulders and stones on the Carpathia lease, on being bagged and sent to a Sydney buyer, proved to be extremely rich, so that the syndicate of six, of which Mr. Keogh was the principal, speedily had a dividend of some hundreds apiece, but some doubt was felt lest this ore should prove to be an isolated patch remaining from a denuded zone, and for some months it could not be realised that bodies of rich tin ore were awaiting development. The ground was gradually prospected, however, and the ore where the Carpathia shaft now is was exposed. At this time it engaged the attention of Mr. W. W. Young, then on a visit of inspection to the "Mallee Hen," a gold mine in the district, and presently the lease was sold for £7,000 cash and something like 10,000 paid-up shares in a company being formed to acquire and develop the property.

Digitized by Google

The area of the lease, P.M.L. 4, was about 15 acres. This sale was followed by that of the White Crystal leases, some five in number, having an area of about 70 acres, the principal being P.M.L. 4, held by Mr. Keogh, for £26,000 cash and a number of paid-up shares. Shortly followed a "boom" period when shares, paid up to a few shillings only, rose to nearly thirty shillings each, and during which several other companies were formed to acquire and develop other leases. These will be mentioned in turn.

For some reason or other, and without the value of the mines or the shares being either proved or disproved, the investing public became alarmed and lost confidence, and share market values depreciated to such an extent that many speculators who bought in a high market lost heavily. This had the effect of causing the field and the mines to be looked on generally with disfavour for some years after, and although the progress made was generally good, and sound work was done giving a valuable output each year, it was long before even a section of the public realised that the Ardlethan field held promise of sound mining propositions and was worthy of attention. The value of the output, collectively and of the various mines, as published each year in the Annual Report and mentioned later on shows that those immediately connected did their best, and much credit is due to the individual lessees who prospected and developed a considerable number of leases. During 1913 a tremendous activity in the taking up of authorities to enter and leases was manifested, and at each fortnightly Warden's Court for some months an average of eighty or ninety applications were dealt with. The Department detailed a special Warden's Clerk, with two Warden's Bailiffs to meet public requirements, and up to the present time nearly 2,000 applications for authority to enter have been made.

A number of Crown Lands leases, principally on stock routes and reserves at Bygoo, have also been taken up, and a total of nearly 600 lease applications have been made, the majority of which have been granted.

The principal mining companies formed were as follows:—The Carpathia and White Crystal, already mentioned, the Wild Cherry, the Southern Cross, Big Bygoo, and Drumlish Hill. The Ardlethan Options also acquired rights over a number of leases, and various syndicates or individuals held and worked leases, such as the Homeward Bound, Champion, Wallace Brothers, Outcast, Outcast Extended, Central Options, Commonwealth, Perseverance, Black and White, Kiora, Vulcan, Killarney, Lone Hand, Dumbrell's Bygoo, Corner's Bygoo, Sholtz's Bygoo, and others.

The Wild Cherry is now known as the New Venture, while the Southern Cross, Drumlish Hill, and Ardlethan Options are either defunct or are not prominent at present. But in every case except that of the Southern Cross, the leases are being worked by later holders with considerable success, and developments appear to justify the hopes entertained when the companies were formed.

The following details relating to some of the various mines may now be recorded:—

The Carpathia has so far been the leading producer, and at the end of 1918 the output amounted in value to over £150,000, the sum of £40,000 having been distributed in dividends; this amounted to a great deal more than the capital raised to purchase and equip the mine.

The New Venture (formerly the Wild Cherry) has contributed tin to the value of £23,000 odd, and has pioneered in the matter of boring for water, a good supply having been found at a depth of something over 200 feet.

Digitized by Google

The White Crystal's output has realised a total of £35,906 during the year, and favourable developments have occurred which may greatly increase the supply of concentrates.

The Southern Cross erected a 10-head battery and plant, but failed to find tin in payable quantities on its leases. The plant has, however, been of incalculable value in the development of the field, as it has regularly treated ore for the public for some years past, and has thus proved the value of numbers of holdings. It has been a tremendous boon to numbers of lease holders and prospectors.

The Homeward Bound, and also Wallis mine, lying west of the New Venture, were highly payable in the early days, and are both promising mines at the present time.

The Bygoo end of the field, though retarded by want of water, distance from battery, and the fact that the majority of the mines were retained and worked by the original finders, is now being developed, and promises favourable developments. Foremost is Big Bygoo, which languished for some five years, but during the last two years has produced concentrates to the value of nearly £20,000. A plant is now being erected on the mine, and the outlook is particularly encouraging.

Dumbrell's Bygoo has produced 1,000 tons, averaging 5 per cent., some of the ore being over 60 per cent.

Corner's Bygoo and Scholz's Block 5 have also produced consistently in the past, but at the present further development work is needed to prove their permanency.

The total production of the field to the end of 1918 had a value of about £343,000, and the output of some of the individual mines was—

	Tons.	£
Carpathia	17,435	156,965
White Crystal	8,000	35,906
New Venture	14,000	23,574
Homeward Bound	1,350	9,570
Wallis	600	6,695
Big Bygoo	2,500	18,644
Dumbrell's Bygoo	1,000	6,350

ACKNOWLEDGMENTS.

It is not necessary to specify individually those who rendered the writer every possible assistance during the field examinations and preparation of this work.

All were willing to render every facility for gleaning information, and assist in every way possible.

Mr. Godfrey's report on the field proved of great help, as also did information supplied by Mr. Warden James regarding past operations and yields.

Mr. Ellis, manager of the Carpathia, was in a position to supply much useful information as to costs, and working or prospecting conditions, whilst special thanks are due to Mr. Terry, manager of the New Venture Mine, for pointing out the surface exposures of porphyry, and underground provings of the same rock.

Digitized by Google

CHAPTER 2.

GENERAL GEOLOGY.

The accompanying geological sketch plan indicates the relative positions of the three principal tin belts in the neighbourhood of Ardlethan, together with the associated geological formations.

The latter may be divided into two groups, namely, sedimentary and igneous, but there is a considerable area of each which is entirely covered with a waste sheet of soil, so that it is only possible to determine the actual contact in a few places.

In addition to the waste sheet above referred to, a considerable accumulation of shed material occupies a depression on the south-west side of Carpathia Hill. This deposit has been proved to be of considerable economic importance on account of its tin contents, and is referred to locally as the "Alluvial Ground."

That it is not a true alluvial deposit is evidenced by the angular and sub-angular nature of the whole of the contained material, and it is best classed as an accumulation of detrital material.

Sedimentary.—The sedimentary rocks consist mainly of quartzites, fine-grained micaceous sandstones, slates, and a coarse breccia formed of fragments of similar rocks, all more or less altered. Known exposures of the latter are not numerous, and are always found in juxtaposition to the granite, the most noticeable exposure being on the Carpathia Hill, where it forms quite an attractive rock type.

East from Ardlethan itself, and extending for many miles north and south of that village, sandstones, in places pebbly, predominate, all dipping at from 20 to 60 degrees to the westward.

Igneous.

Granite.—At a period subsequent to the folding of the sedimentary rocks an extensive granitic intrusion forced its way into the belt of country lying some 3 miles west of the village of Ardlethan.

This intrusion consists of alternating belts of coarse and fine grained granite or aplite, and can be traced many miles north from Ardlethan, whilst it was followed south as far as Bald Hill, some 8 miles to the south-west.

The width ranges from 5 to 8 miles, but as a large part of the land surface is covered with a waste sheet, its actual boundaries are for the most part obscured.

Porphyry.—At a still later stage, the granite was intruded along its eastern edge by a dense quartz-felspar,-porphyry.

Five surface exposures of this rock were located in the vicinity of the Carpathia group of mines, and it has been exposed in several of the mine workings.

Most of the surface exposures resemble dyke outcrops, that is, are relatively much longer than they are wide, but about 1 mile west from Carpathia Hill an outcrop occupying some six or seven acres is to be seen.

Digitized by Google

DETAILED GEOLOGY.

Sedimentary.—As already pointed out, no palæontological evidence as to the geological age of the sedimentary beds has yet been obtained, but, on lithological grounds, the writer strongly favours referring them all to the Devonian period. Some 10 or 12 miles south from Ardlethan, at Murril Creek, in the neighbourhood of the Mallee Hen Gold Mine, a belt of steeply dipping, highly fossile clay slates occurs. These beds differ entirely from the sedimentary rocks found adjacent to the Ardlethan tin belt, and are of a lithological type nearly always associated with beds of Silurian age. On the other hand, the sedimentary rocks near to Ardlethan have all the characteristics of proved Devonian beds in the State of New South Wales.

The present writer's opinion as to the age of the sedimentary rocks adjacent to the Ardlethan tin belt is arrived at in the light of the foregoing evidence, and it is considered that any local variation in proximity to the granite intrusion is due to contact metamorphism. These views, however, yet remain to be confirmed by palæontological evidence, of which none was obtained during the recent examination.

In the writer's opinion prospecting in these beds is not likely to lead to important mineral finds, unless it be in proximity to the granite or porphyry contact. It may be, however, that apophyses of the latter intrusion will be found at no great depth beneath the surface along the western boundary of the sedimentary rocks, in which case mineral deposits (tin, wolfram, &c.) may occur, but these would undoubtedly be mainly confined to the porphyry.

The breccia referred to has probably been partly formed at the close of the granite intrusion, by more or less open spaces being left in places between the surface of the granite and the overlying sedimentary rocks, for wherever the contact could be observed, a sharp line of demarcation exists between the two. This would lead to a shelling off of the latter and a loose accumulation of angular fragments in the shrinkage cavities.

The solutions accompanying the porphyry intrusion then deposited their mineral contents in the loosely packed fragments, thus forming a compact rock mass. The breccia in places is charged with tin oxide and copper carbonates, and this, in the writer's opinion, goes far to substantiate the theory that the mineral contents of the Ardlethan tin field are attributable to the porphyry intrusion. In the large open cut within the Champion leases, an excellent exposure of breccia is to be seen. The cut started in granite the intrusive nature of which is well seen here, but soon passed through it into the brecciated sedimentary rocks. A pronounced fault is seen close to the contact, striking north 30 deg. east, and dipping north 60 deg. west at an angle of 42 degrees, but the amount of displacement could not be determined.

A prominent outcrop of porphyry is to be seen adjacent to the open cut, and the writer attributes the fault to the intrusion of that rock, for similar fault planes were identified in the granite itself, thus proving that faulting took place subsequent to the intrusion of that rock.

Granite.

Intrusive.—The geological age of this intrusion is apparently post-Devonian, for it is seen intruding rocks to which that age has been assigned, and it appears reasonable to assume that it took place during the Carboniferous period in common with many other granite masses in New South Wales.

Digitized by Google

There has been considerable magmatic differentiation, and several distinct types were observed. These occur in belts from a few feet up to many yards in width, with a more or less meridional strike.

As the mass is crossed from east to west, the most noticeable features are that the eastern periphery consists largely of a highly acid type over much of the exposed area, that is, the comparative absence of felspar is very marked, and mica is only sparsely dessiminated through the rock, or occurs in isolated bunches.

Secondary silicification has undoubtedly played a large part in the present composition of this granite type, apart from its original composition.

The writer is of the opinion that the porphyry intrusion was accompanied by highly-charged mineral solutions, which impregnated the rock mass within their scope of influence, and also replaced portion of the original constituents. In other words, they not only dissolved out most of the felspar constituents, but replaced them by amorphous silica, metalliferous deposits, and, in some cases, by topazisation and other alteration products.

Continuing west, the granite is found to become more holocrystalline, and to contain a comparatively high percentage of felspar, with an equivalent increase in the ferro-magnesian constituents.

These belts alternate with either semi-acid or a fine-grained variety of rock. In the latter, a marked association of tourmaline is present.

All the available evidence points to the more acid type of granite being most favourable for the occurrence of payable deposits of tin ore, and this should be a sound guide to prospectors.

Porphyry.—That there has been an intrusion of porphyry subsequent to the granitic intrusion is evidenced both on the surface and underground in mine workings.

Five surface exposures were located, as shown on the accompanying geological sketch map, and a number of occurrences are to be seen in the underground workings. These are best seen in the "alluvial ground" of the New Venture mine, but other occurrences noted were in a shaft on a lease held by the Ardlethan Options, at present being worked on tribute by Mathieson and party (P.M.L. 157, parish Warri).

One or two exposures were examined in the Carpathia mine workings, which probably represent the porphyry, but here advanced alteration renders a definite identification impossible, even under the microscope.

In other cases certain highly altered rocks have been classed as porphyry by mining men on the field, but it appears probable that these represent phases of the original granite intrusion, probably in close proximity to the later intrusion, and consequently much altered.

The surface exposures of porphyry have all the appearance of comparatively narrow dykes, or might even be attributed to magmatic differentiation, but underground work proves that a large mass of porphyry underlies the granite in this neighbourhood, and has intruded it. In other words, the surface exposures represent narrow apophyses of porphyry extending upwards beyond the main mass.

Digitized by Google

The bulk of the exposures disclose a typical quartz porphyry, the porphyritic crystals consisting of glassy quartz, which are embedded in a light-grey base, probably more silicious than felspathic.

In places the outcrops disclose a much pitted rock, due to the quartz crystals becoming detached from the surrounding base.

The exposure in the south-west corner of portion 19, parish Ramsay, about half a mile north-west of the Ardlethan Mines Public School, consists of a dark-blue felspar porphyry, with an almost entire absence of visible quartz, but the writer considers this to represent a portion of the porphyry intrusion in which the felspar has developed at the expense of the quartz.

The relative age of the porphyry intrusion is incapable of proof, but the writer inclines to the opinion that it took place at no great period after the granite intrusion, and represents renewed activity in the original magma basin.

Mr. E. C. Andrews, B.A., Geological Surveyor, in dealing with the ore deposits associated with the New England granites(*) points out that "into the late Palæozoic strata a number of granitic rocks were thrust, the earlier ones being basic varieties, the younger members being of much more acid types."

This, in the writer's opinion, premises the genealogical conditions which pertained on the Ardlethan tin field, and a post-Devonian age must be assigned to both the granite and the porphyry, with the latter intrusion post-dating the former.

Although the presence of porphyry was only observed in the positions mentioned, the writer holds the view that the secondary silicification of the granite, with accompanying metallic mineral deposition found along the eastern periphery of the granite at the Bald Hill, Carpathia, and Bygoo groups of mines, is due to that intrusion.

The reason for this assumption is based on evidence that is more or less intangible, but may be summarised as follows :—

1. The tin deposits have already been traced down into the porphyry in several instances, thus establishing a genetic connection.
2. The ore bodies are almost entirely associated with an altered acid type of granite. This alteration is most marked in the neighbourhood of the porphyry outcrops, or along the belt of country likely to be affected by that intrusion, *i.e.*, the junction between the granite and sedimentary rocks.
3. If the origin assigned to the breccia be correct, it naturally attributes its silicification and mineralisation to a later period than the granite intrusion.

True, there are no direct evidences of the porphyry at either the Bald Hill or Bygoo ends of the field, but the geological horizon, *i.e.*, the contact line between granite and sedimentary rocks is the same in each case, and the alteration products are identical.

(*) "The Geology of the New England Plateau, with special reference to the Granites of North New England," Geological Survey Records, Vol. VIII, part 2, p. 110.

Digitized by Google

CHAPTER 3.

THE NATURE AND PROBABLE GENESIS OF THE ORE BODIES.

The ore bodies on this field may be divided broadly into two classes, namely :—

A. Deposits *in situ*; and

B. Deposits of shed tin, referred to locally as the "alluvial ground."

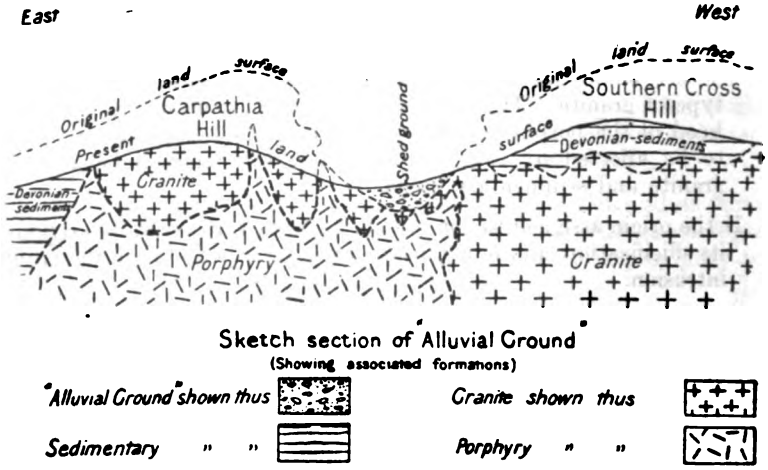
Class A. consists of :

1. "Bungs," pipes, and irregular-shaped bunches or lenses.
   These are found lying at all angles to the horizon, and are apparently indiscriminately disseminated through the belt of country affected by the porphyry intrusion. The ore bodies vary in size from small isolated kernels to pipes over 40 feet long, 30 feet wide, and a vertical height of upwards of 100 feet, with average tin values up to over 20 per cent. tin.
2. Impregnated zones containing finely disseminated cassiterite, which merge imperceptibly into the surrounding country, and are common along fault planes.
3. Face tin, consisting of crystalline cassiterite deposited upon joint faces of the altered granite, which in itself carries practically no tin.
4. Veins of tin-bearing material (mainly silica), deposited actually in fault planes and along parallel zones of stress, whereby permeation by the tin-bearing solutions was facilitated.

Class B.—Deposits of shed tin, or the so-called "alluvial ground," have so far only been found along the drainage system lying between the main Carpathia group of mines, and a range of hills upon which the Southern Cross battery is situated, the locality being indicated on the accompanying geological map.

Many thousand pounds worth of tin have been recovered from this ground, the nature of which is somewhat unique in the writer's experience.

The following sketch transverse section illustrates the nature of the deposit :—

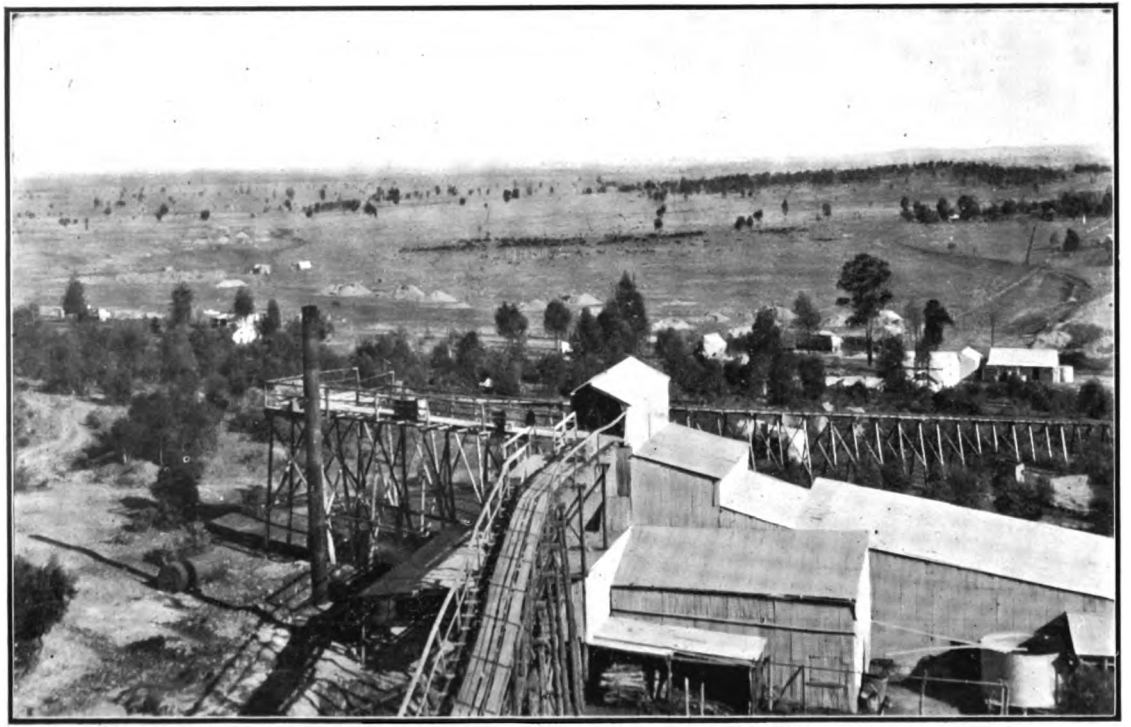


Sketch section of Alluvial Ground
(Showing associated formations)

"Alluvial Ground" shown thus
Granite shown thus
Sedimentary " "
Porphyry " "

Digitized by Google

Digitized by Google



"Alluvial Ground" from New Venture Mine.

Digitized by Google

With regard to the genesis of tin deposits in general, the reader is advised to refer to "The Tin Mining Industry, and the Distribution of Tin Ores in New South Wales."*

In that publication Mr. J. E. Carne, F.G.S., Government Geologist, gives a concise epitome of the views held by the world's leading authorities regarding the genesis of tin deposits.

The following are the opinions held by the present writer regarding the genesis of the Ardlethan tin deposits:—

As already stated, the mineral deposits of this field are, in the writers' opinion, intimately associated with the porphyry intrusion, for not only do we find the ore bodies extending down into that rock, but in every instance they are associated with the alteration and replacement products which were undoubtedly the result of that intrusion.

It is considered that the vapours and solutions accompanying the porphyry intrusion were heavily charged with mineral contents, which were deposited within the cooling zone, both of the porphyry itself, and the overlying rocks. The importance of this, in the writer's opinion, cannot be over-estimated, for not only does it offer a guide in carrying out prospecting work, but also points to a far greater degree of permanency for the ore bodies than might have otherwise been attributed. For instance, the proving by the manager of the New Venture mine, that high tin values extend down into the porphyry for at least 50 feet, shows that conditions for the precipitation of tin ore were favourable in the parent or genetic rock.

Other conditions being equal, such as precipitating agents in the presence of solutions capable of in part replacing the original rock, it is what might be expected, for the *cooling zone* in a large intrusive mass coming from unknown depths, would not be confined to rocks immediately surrounding it, but also extend downwards into that rock itself, possibly to a considerable depth.

Right here it might be advisable to point out that not only would the tin contents of the solutions by which it was introduced be more or less limited, but also that favourable conditions for tin precipitation did not exist over the whole zone referred to. Hence extensive blanks are inevitable, and the miner must expect to have to carry out considerable dead work between makes of pay ore.

Origin of the Deposits of Shed Tin.

There is no doubt that bodies of running water did not cause this accumulation, for the recorded annual rainfall of this district (19 inches per annum) precludes the possibility of any large accumulation of truly water-borne material during recent times, and there is no evidence in this district of an accumulation of water-borne material during the Tertiary period.

The Ardlethan "alluvial" occurrences are, in the writer's opinion, due entirely to accumulations of shed material, derived from a more or less vertical escarpment or cliff line. In other words, that during Post-Tertiary

* Mineral Resources, No. 14, Geological Survey of New South Wales, by J. E. Carne, F.G.S., Assistant Government Geologist, Sydney, 1911, pp. 20–26.

Digitized by Google

and geologically recent times, there existed a steep declivity to the west of Carpathia Hill, and also in places on the Southern Cross hillside. The waste material from this escarpment was shed into a drainage channel with a gentle southerly fall, as evidenced by present-day mine workings.

There was apparently not sufficient flow of water to remove the material, hence its accumulation practically where it had fallen.

At the top or northern end, the detrital material consists almost entirely of decomposing granite fragments embedded in a red clay, with occasional fragments of sedimentary rock, porphyry, and tinstone, whilst much of the clay itself carries tin values. The rock fragments range in size from an inch or two to several feet in diameter, and are so bound together by the clay matrix, that practically no timbering is required in the workings.

The above material rests on an uneven floor of either granite or porphyry, the former being more or less decomposed, but the latter only showing slight signs of weathering.

As the "lead" is followed down, the detrital material consists essentially of fragments of sedimentary rock, all of smaller dimensions than the granite detritus, embedded in clay, and resting on a floor of decomposed slate. With the above are associated a fair percentage of angular and subangular fragments of cassiterite, more or less in layers.

The depth of sinking ranges from 25 feet at the southern end up to 86 feet at the northern end (New Venture workings), or head of the "lead." This appears somewhat anomalous, but is explained by the fact that the present land surface falls more rapidly than the ancient one.

The payable tin contents in the lower portion of the "lead" is confined to two or three horizons, the top layer being about 15 feet from the surface, No. 2 about 25 feet, and the other just above the bed rock. At the northern end the values are found to be more or less indiscriminately distributed throughout the entire occurrence.

"Spuds," or nodules, rich in tin contents, have been unearthed up to 30 lb. in weight, but the bulk of the tin contents ranges in coarseness from the consistency of granular sugar to that of walnuts.

The whole of the material from the New Venture leases is sent direct to the battery, and averages just over 1 per cent. tin, whilst lower down (Winter's leases) the layers of payable tin-bearing material, ranging in thickness from a few inches to over a foot, is passed through wire-netting screens, up to one and a quarter inches in diameter, the screenings being sluiced in ordinary riffle boxes, whilst the coarser material is hand-picked, and the best of it sent to a battery for treatment. The sluiced concentrates average about 69 per cent. of metallic tin, and returns from the battery show a recovery of from 5 to 10 per cent.

From the lower portion of the lead, the yield ranges up to three hundredweight of tin oxide per load (22 cub. ft. of dirt), but it is not found profitable to handle the material if the tin contents is below from 15 to 25 lb. per load, depending upon the price of tin and working conditions.

Digitized by Google

SUGGESTIONS AS TO PROSPECTING.

An effort is made in this portion of the paper to use terms, or to so qualify them, that they may be readily understood by the ordinary prospector, to whom the following suggestions may prove useful.

If the deductions arrived at as to the origin of the tin deposits on this field be correct, and there appears good grounds for accepting them, not only from the evidence obtained on the Ardlethan field, but from the generally accepted nature of tin deposits all over the world, the following suggestions should apply.

The most favourable belt of country to prospect is, in the writer's opinion, along the eastern edge of the granite mass, and within this belt attention should be devoted to makes of an acid type of granite, that is, one in which silica (quartz) predominates, or to zones in which the granite contains a preponderance of mica over felspar.

Particular attention should be devoted to locating occurrences of quartz porphyry, that is a more or less compact rock containing separated grains of glassy quartz. Even if the porphyritic (readily distinguishable as compared with the ground mass) grains be felspar, favourable developments may take place.

In underground work the same factors apply, and whilst it is not possible to definitely indicate the position of makes of pay ore, pronounced joints, or makes of "channel material," veins of ironstone, &c., might be followed with advantage.

The miner is advised to become acquainted with the porphyry referred to, and once it is proved in mine workings, to keep in touch with it.

Digitized by Google

CHAPTER 4.

PAST AND PRESENT MINING, TREATMENT PLANTS, NATURE OF, ORE, RETURNS.

There is no doubt that the nature of the tin occurrences within this area were not fully realized in the early days of the field, and the original identification of the tinstone was arrived at from shed material, so that an expression of opinion upon the evidence then available was difficult.

The prospecting results were so encouraging, however, that enthusiasts like Mr. J. J. Keogh and others persevered, and eventually succeeded in introducing capital into mining ventures, which were practically unknown quantities, but with potentialities at that stage undemonstrated.

There ensued a boom time, when fabulous prices were offered and paid for various properties, many of which never showed any justifiable inducements for their flotation.

In the past some of the companies floated were fortunate enough to be able to operate on rich bungs of tin ore, which yielded handsome returns right from the start, but in a short time these " bungs " were worked out, and it became necessary to undertake underground prospecting work in search of new makes of payable ore. In many cases there was no available capital to carry out the necessary dead work, and many claims were abandoned.

The early returns of tin produced, as published in the Annual Reports of the Department of Mines, are as follows :—

Year.	Returns.
From June, 1912	500 tons (379¼ tons sold for £7,741).
1913	£42,536.
1914	£25,332.
1915	£53,771.
1916	£29,593.
1917	£62,069.
1918	£77,385.

It is not possible at this period to give the returns from each individual mine or claim, but there is no doubt that the Carpathia Company has been the largest and most consistent tin producer, and whilst the production at the Bygoo end of the field has been good, very little tin has been recovered from either Bald Hill, at the southern end, or Taylor's Hill, to the west of the Carpathia group.

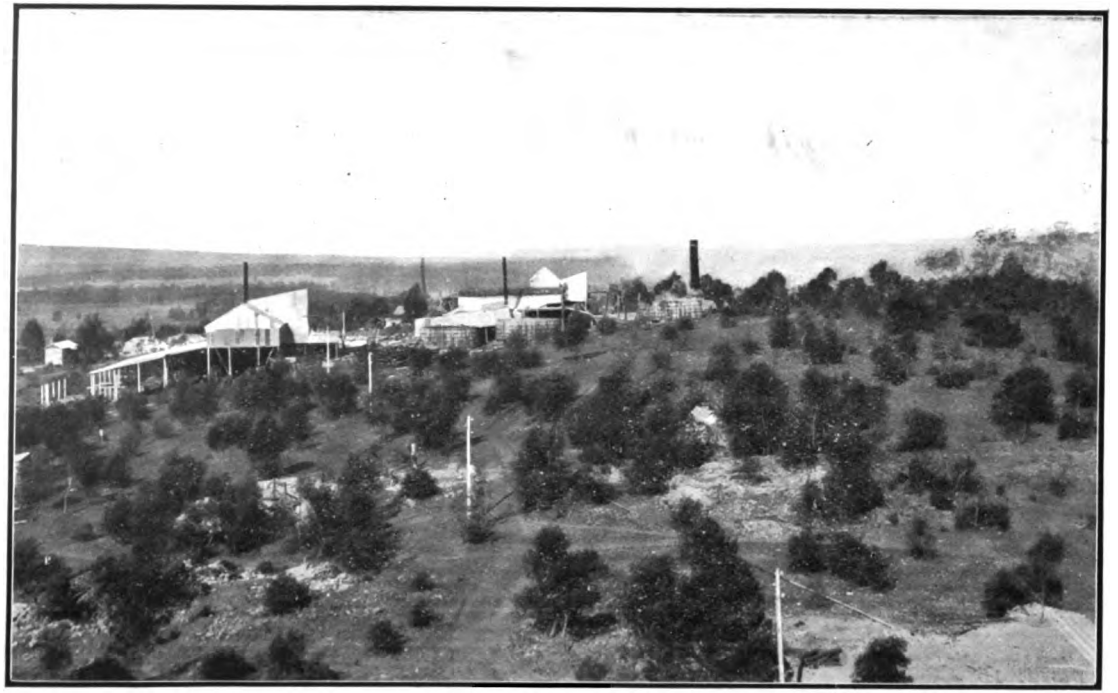
Particulars of the various claims worked or prospected are published in the comprehensive report by Mr. J. R. Godfrey, already mentioned, and the reader should refer to that publication for details.

During the present year, some eight or ten properties have been producing tin, but the bulk of the ore won has come from the following mines :— Carpathia, New Venture, White Crystal, the " Alluvial " Claims, and Big and Little Bygoo.

There are at present (June, 1919) five batteries engaged crushing ore in the Ardlethan field, namely :—The White Crystal, Carpathia, New Venture, Southern Cross, and Little Bygoo, whilst the Carpathia Company also have a battery at Barmedman.

Digitized by Google

Digitized by Google



Carpathia Mine.

Digitized by Google

The following mines were actively engaged during the inspection of the field :—

The Carpathia Mine.

The Carpathia leases apparently embrace an area very much affected by the porphyry intrusion, for not only are surface exposures of that rock found on three sides and in the centre of the leases, but underground work has proved that there are probably occurrences of it at the 200-feet level.

The main shaft has reached a depth of 200 feet, with a drive south for 150 feet, from which there is a crosscut 120 feet to the west. From the same level a drive extends 200 feet to the north, thus connecting No. 1 and No. 4 shafts. From the foot of the shaft at this level, a crosscut has been driven 44 feet in a southerly direction, from the end of which a winze has been sunk to a depth of 102 feet below the shaft. During June of the present year the winze was passing through a very rich pipe of ore, the proved dimensions of which were 35 feet long, 26 feet wide, and 75 feet deep, the average tin yield being from 18 to 20 per cent., with patches yielding up to 60 per cent. ore.

In what is known as No. 4 shaft, the country penetrated consists mainly of a coarse breccia, containing both tin and copper values, and from rock specimens collected at the 200-feet level there is every reason to believe that the porphyry is very adjacent if not actually cut. Somewhat similar conditions are to be seen at the south end of the 200-feet level, and as the presence of both the porphyry and breccia is considered a favourable indication, prospecting work in the neighbourhood of either is likely to prove makes of pay ore.

The large chute of ore proved in the 44-feet winze was located by following a make of soft granite heavily charged with iron pyrites, manganese oxide, chlorite, &c., but for the most part practically devoid of tin values.

The following particulars regarding the plant of this mine were kindly supplied by the secretary of the company :—

> At Barmedman we have 15 head of stamps, small reverberatory roasting furnace, Wilfley tables, Frue vanners, rotary tables, grinding pans and buddle; whilst at Ardlethan the battery consists of 10 head of, say, 800 lb. stamps. The screens used are 12 and 14 mesh. There are also a rock-breaker, May jig, 1 set of Spit-Kasten classifiers, 4 Wilfley tables, 3 Frue vanners, 1 Krupp ball mill, 1 Edwards Duplex roasting furnace, and 1 small reverbatory roasting furnace. The mill has been erected this year and will, we hope, soon be completed.

The following returns of the output from this mine were supplied by the same authority :—

	Tons Ore raised.	Tons Concentrates produced.	Value. £
Period ending 31st July, 1913	1,357	202	21,765
Year ending 31st July, 1914	5,430	367	32,129
„ 31st July, 1915	1,674	154	13,675
„ 31st July, 1916	2,998	198	18,014
„ 31st July, 1917	3,410	152	16,702
„ 31st July, 1918	2,102	182	31,827
„ 31st July, 1919	1,735	203	26,530
			£160,642

Ore sold—	£
31st July, 1913—62 tons ore realised	4,132
31st July, 1914—11 „ „	763
31st July, 1917—18 „ „	2,113
31st July, 1918—12 „ „	1,989
	£8,997

Digitized by Google

The accompanying longitudinal section of the mine workings was kindly supplied by the management, and affords valuable information as to the extent of ore bodies proved to date.

The ore won is classified as follows :—

·7 to 3	per cent. tin	..... "Seconds."
3 to 14	,,	..... "Millings."
15 to 30	,,	..... "Special milling."

Anything over this, and some of the ore goes as high as 63 per cent. tin, is termed selected.

The seconds and selected ore are treated on the ground, and the milling and special milling at the Barmedman battery.

The concentrates are sold to Mr. T. H. Kelly, of Sydney, and the following information from account sales placed at my disposal by the manager affords interesting information as to the nature and value of the concentrates.

In April, 1918, sixty-eight bags of ore, weighing 4 tons 19 cwt. 2 gr. 15 lb., showed an assay value per unit of 58/9, the toal value per ton being £176 5s.

The impurities as determined by assay are as follow :—

Material.	Sulphur.	Arsenic.	Copper.	Bismuth.	Lead.	Wolfram.
Ore	2·90	1·55	0·42	0·35	·0·55	0·70 per cent.
Concentrates	2·75	1·45	0·38	0·50	1·20	1·00 ,,
Calcined concentrates	0·20	0·18	0·10	0·10	0·35	?

The above may be considered a fair average of the percentage of impurities present, but a casual examination of crude ore on the trucks would lead one to expect them to be much higher.

The White Crystal Mine.

No outcrops or exposures of true porphyry were found on this company's property, but it was located on the surface a chain or two beyond the most northerly corner of the leases held. There is strong evidence, however, that an extensive intrusion of that rock will be found at no great depth, for the granite over much of the area held, particularly on Crosby's or the White Crystal Hill, show secondary silification and replacement to a marked extent, such, in the writer's opinion, being due to the action of the vapours and solutions which accompanied the intrusion of porphyry.

The proving of a pronounced fault plane along the 40-feet intermediate level (which is 308 feet long), striking north and south and dipping west at 60 degrees, may also be taken as evidence of the presence of a body of porphyry at no great depth.

Admitting that surface conditions represent a zone affected by the porphyry intrusion, but further away vertically from the mass of that rock than is the case in the Carpathia and New Venture leases, then the deduction is obvious that by deeper sinking, larger and more concentrated ore bodies may be expected.

The main shaft on this property is down to a depth of 240 feet (vertical). An intermediate level has been driven south for 308 feet at the 40-feet level, but the main levels are only driven 100 feet and 156 feet, the former bein known as No. 1 and the latter as No. 2.

Digitized by Google

Digitized by Google

Th
supp
exte
Th

A
is te
Th
and
Th
infor
inte
In
shov
£176
T

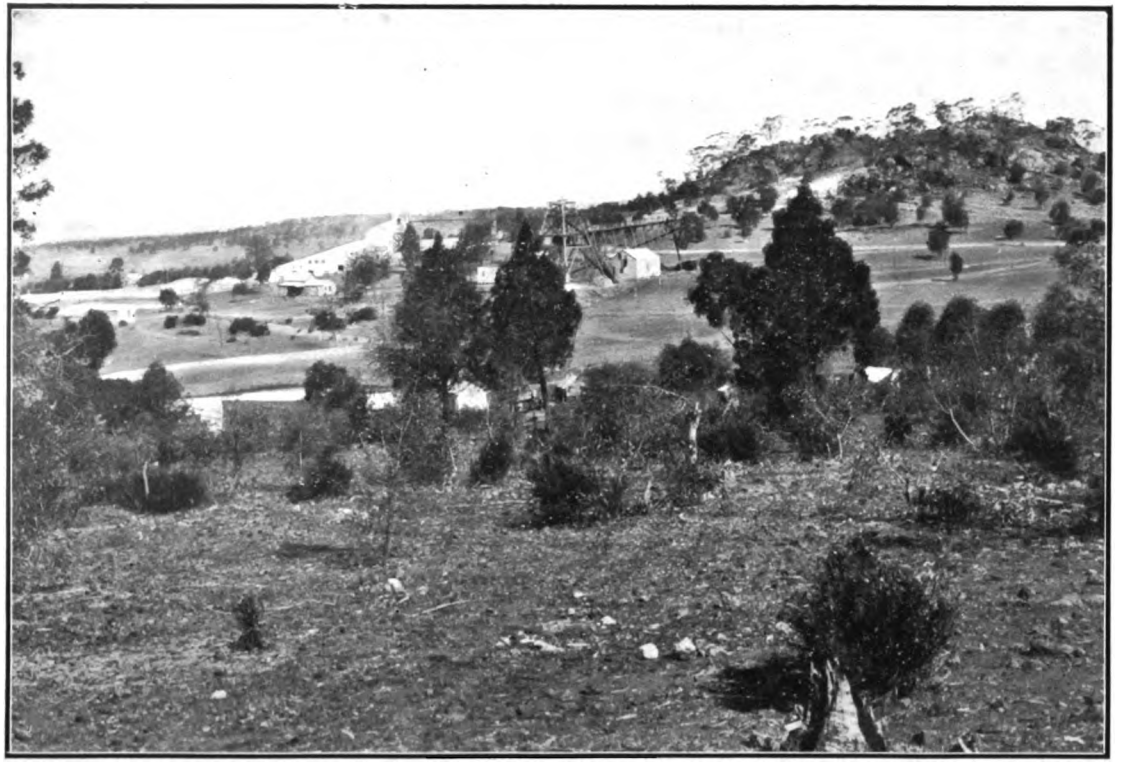
Ore
Con
Calc

T
ties
one

N
pro
nor
an
gra
Cry
ext
and
T
lev
60
por
A
por
tha
is
ma
T
An

Digitized by Google

Digitized by Google



The White Crystal Mine.

Digitized by Google

At the time of inspection, a shallow winze from No. 2 level was exposing a nice chute of pay ore, but insufficient work had been done to enable an estimate to be formed as to its probable dimensions. Portion of the ore at present being won from the shaft workings is somewhat dirty, and has to be roasted, as is the practice of other mines on the field. This is rendered necessary by the presence of iron and arsenical pyrites, bismuth, &c., and an analysis of a typical sample of *roasted* ore is as follows :—

Sulphur.	Arsenic.	Lead.	Bismuth.	Copper.	Wolfram.
0·5	0·3	0·2	0·1	trace	3·2

The occurrence of wolfram within the area held is more pronounced than in other parts of the field, and may prove somewhat of a disadvantage, for it is found that the bulk of the concentrates sold contain from 2 to 3 per cent. of wolfram.

An attempt was made to work Crosby's Hill by means of an open cut, the whole of the material won being treated, but values appear to have been too low to pay.

A tunnel was then driven into the hill for a distance of 75 feet, on the left-hand side of the open cut, following a make of pay ore. At 50 feet, crosscuts have been driven in an easterly and westerly direction, the faces now being about 40 feet apart.

This work has proved the existence of an extensive make of ore, all of which it is expected will pay to treat. About halfway along the tunnel, a rise has been put up for 70 feet to the floor of an excavation near the crest of the hill, and the material won is all sent to the battery. No definite information as to the value of the ore now being raised from Crosby's Hill is available, but it is estimated to yield in the neighbourhood of 2 per cent. of tin.

The total production of the White Crystal Tin Mining Company, as published in the Annual Reports of the Department of Mines, is as follows :—

1913.—235 tons of ore sold for £3,132 early in the year. Total ore raised, 750 tons.

1914.—200 tons of ore raised.

1915.—Production valued at £17,386.

1916.—32 tons of concentrates, valued at £2,560.

1917.—2,500 tons of ore raised, and concentrates produced to the value of £8,107.

1918.—Production valued at £2,971, whilst tributors recovered over £3,000 worth of tin.

During the first six months of 1919, 2,452 tons of ore yielded 45 tons of concentrates, according to the manager.

The plant installed at the White Crystal mine is both up-to-date and efficient, but more power is desirable, whilst the water supply is adequate for all requirements, namely, a tank capable of storing twenty million gallons; so that given a continuous supply of payable ore for treatment, the company should be in a position to justify the capital expended, although developments prior to the present geological survey do not appear to have been too encouraging. There is reason to expect more favourable developments at a greater depth, however, should the writer's views prove correct.

Digitized by Google

The plant consists of two suction gas engines of 50 and 30 h.p. respectively. An electric generator is installed for the purpose of driving a pump at the main dam, also a complete lighting plant.

The ore is first passed through a Jake's rock-breaker, and fed thence to 10 head of stampers, weighing 1,250 lb. each, discharging through a 10-mesh screen. After passing through a classifier, it is treated by three jigs, the coarser material being fed to a grinding pan and thence to two Wilfley concentrating tables, whilst the overflow passes into Callow tanks.

After treatment on two Frue vanners, it passes through the roasting chamber, and the former treatment is again repeated.

The New Venture Mine.

A portion of the present New Venture Company's leases were originally known as the Wild Cherry Mine, and whilst a few rich "bungs" of tin ore were worked in the early days of the field, the original company eventually got into difficulties, and the new company was formed.

On field evidence, there is good reason to expect favourable results from the leases now held, for not only does the porphyry outcrop prominently, but underground workings have cut it in many places, and payable tin ore has been followed down for over 50 feet in that rock.

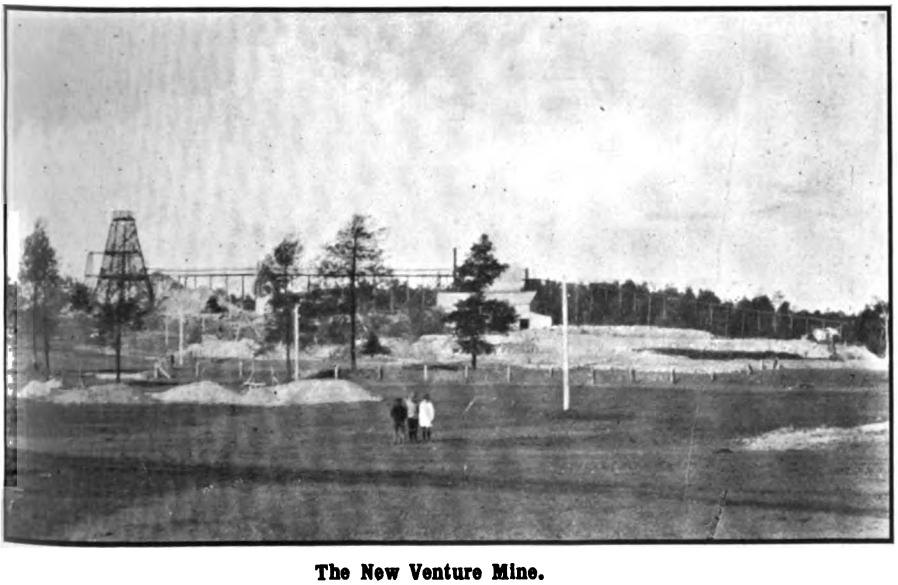
Mr. Terry, manager for the company, has realised the importance of the porphyry intrusion, and much of his prospecting work has been carried out with a view to prove the occurrence of ore bodies actually in the porphyry, and the *significance* of its proximity with regard to the likely occurrence of payable deposits of ore.

The present company has acquired additional areas of tin-bearing formations, particularly within the "alluvial" belt, the importance of which had not hitherto been realised, with the result that they now hold an extensive tin-bearing area which promises to yield satisfactory returns if handled as a large low-grade proposition.

The main shaft on the lode tin deposits is down to a depth of 150 feet, and considerable driving, crosscutting, and sloping has been done, but at the time the writer was on the field very little ore was being recovered here, as work was confined mainly to prospecting and winning ore from an adjoining shaft known as Hough's. This shaft is down to a depth of 100 feet, and yielded some very rich ore during the early days of the field. The present company are driving towards the porphyry, an outcrop of which is seen on the surface some two chains easterly from the shaft.

The "alluvial ground" is at present worked by means of an inclined shaft, which leads to workings up to 86 feet below the surface, but there is no doubt that open cut methods must eventually be adopted if safe and economic working conditions are considered. According to the manager, from twelve to thirteen thousand tons of material have been treated from this ground for a return of from ¾ to 1 per cent. of tin, which, whilst not yielding any profit to the investors, payed all expenses, and provided a sinking fund, wisely to be devoted to the erection of a more adequate and economical treatment plant.

Digitized by Google



The New Venture Mine.

Digitized by Google

Digitized by Google

The following returns for the four half-years, 1917-18, were supplied by the manager :—

		Tons of Ore Treated.	Concentrates.	Average Yield from Concentrates.
				per cent.
1917	First Half-year	1,238	21	1·7
	Second Half-year	2,812	37	1·3
1918	First Half-year	3,000	27	·9
	Second Half-year	3,183	27	·8

From the foregoing it will be seen that the bulk of the ore treated was low-grade, but by economical management, despite unfavourable working conditions, and a practically worn-out plant, all working costs were met, and a sinking fund provided for an up-to-date and extensive plant.

Mr. Terry gives his working costs as follows :—

Mining, &c. ..... £1 0s. 5d. per ton.
Crushing ..... 5s. 9d. ,,

Two shifts were worked, and the crushing was done by the battery referred to. The plant consists of a rock-breaker and denny grinder, 10 head of 1,000 lb. stamps discharging through a 10-mesh screen, feeding to five Card concentrating tables (one used for slimes only). The plant is driven by a 10 h.p. Jackass boiler, whilst another 10-15 h.p. boiler is used for winding. The new treatment plant is now in course of erection, and should be completed by the end of the year.

Provision has been made for an adequate water supply, and in addition to two large dams, a bore was sunk to a depth of 460 feet, adjacent to the main shaft, from which 10,000 gallons of water are now being pumped in the two shifts worked per day, the water rising in the bore to the 360-feet level.

Other "Shows"—Carpathia Group.

In addition to the foregoing companies in the Carpathia group of mines, there are several smaller companies or syndicates occupied in prospecting leases held.

None of these are at present producing tin ore to any extent, but in the case of those adjacent to the porphyry intrusions shown on the accompanying map, the writer is of the opinion that the possibilities of locating makes of pay ore are favourable. There is little doubt that several of these shows have possibilities, but unless they are worked as low-grade propositions, *i.e.*, economic bulk treatment, considerable dead work must be expected if rich "bungs" are to be located.

None of these shows are equipped with a treatment plant, but a public battery, known as the Southern Cross, is situated within a mile of any of them, and here parcels of ore can be treated at what appears to be a reasonable cost. This plant is provided with a Blake rock-breaker, a 10-head stamper battery (1,000 lb. stamps) discharging through 8 and 10 mesh screens.

Digitized by Google

with four classifiers, two Wilfley and two Card concentrating tables for primary treatment, and two Card and one Wilfley for secondary. The middlings are passed through a classifier, whilst the coarser material is treated on a Wilfley table, and the fine on a Card table, the resultant residues being treated by a pulp thickener and then on a Card table.

The plant was erected in December, 1914, and, although the water supply is limited, every effort is made to meet the public requirements. Delays naturally occur, due either to the limited water supply, or an extra rush of parcels of ore for treatment, but there is no doubt that this battery is capable of dealing with all public crushings from the field.

As the "alluvial ground" has been dealt with at some length in the earlier part of this paper, no further mention need be made.

Bygoo Group.

This end of the Ardlethan field is situated from 3 to 4½ miles north-west of the Carpathia group, Bygoo being the first tin-bearing area, and Little Bygoo, 1½ miles further on, the next exposure of stanniferous rock.

There is no doubt that some good returns of tin were obtained in the early days of the field from surface "bungs" of ore, but at the present the working propositions appear to be dependent more upon the recovery of tin from belts of comparatively low-grade material.

Although the presence of porphyry has not yet been proved at this group of mines, judging by the nature of the occurrences, there is little doubt that they owe their origin to an intrusion of that rock, and the writer fully expects that it will be reached at no great depth.

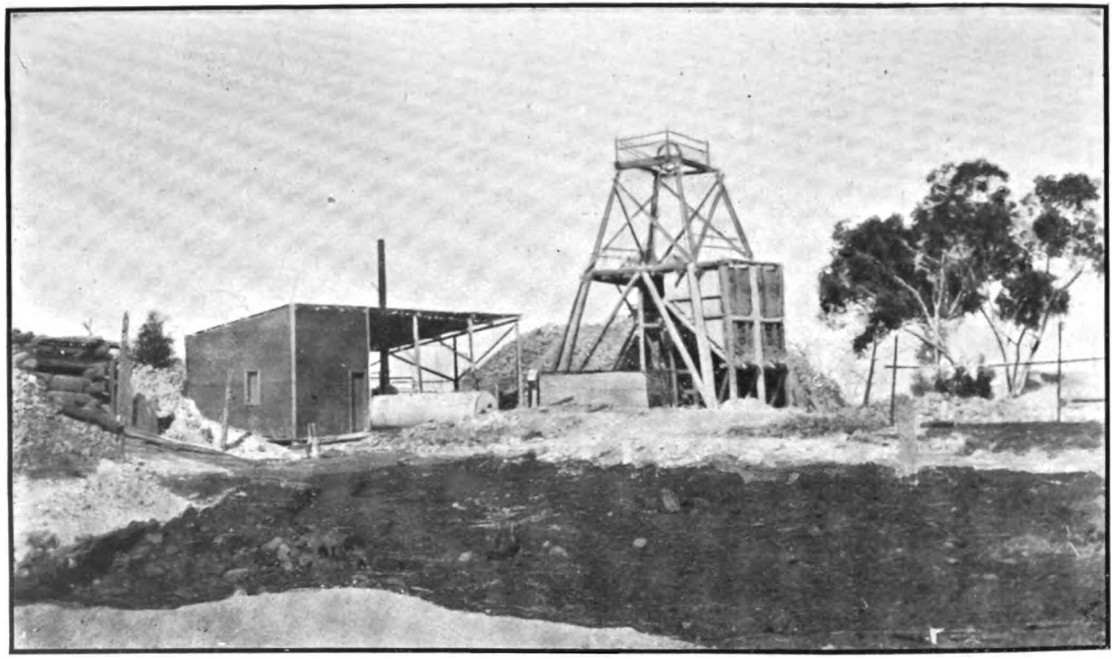
The Big Bygoo property embraces an area of mineral-bearing leasehold which includes the original Big Bygoo leases, the Lone Hand, and adjacent areas. Here we find six separate outcrops of a highly siliceous type of granite, surrounded on three sides by a more or less basic type, in which felspars predominate.

This company is at present winning ore from several belts of altered granite, the most easterly one of which has an area of approximately half an acre. Two shafts have been sunk on this to a depth of 90 and 70 feet respectively, and connected by a level 60 feet long. Very little stoping has been done, but good parcels of ore were obtained from the shafts, &c. Much of the material present in this occurrence is almost entirely composed of silica, and in addition to the tin contents, very large makes of tourmaline occur.

The ore now mined averages about 5 per cent. tin, and is free from impurities. Up to the present the ore has been carted to the Southern Cross battery, at the Carpathia group of mines, some 6 miles distant. Under these circumstances only the richer bunches were worked.

At the present time a 10-head stamper battery and the necessary concentrating plant (ten tables) is being erected near the centre of this group of tin occurrences, and a tank to conserve water, with a capacity of 3,000,000 gallons has been excavated 1¼ miles from the battery, but, owing to the absence of rain, it is still dry. Some 35 chains south-west of the shafts referred to, a

Digitized by Google



Big Bygoo Mine.

Digitized by Google

Digitized by Google

belt of tin-bearing siliceous granite is being worked by open cut. This occurrence is approximately half an acre in extent, and, up to the present, bulk crushings point to the average tin contents being in the neighbourhood of 2 per cent. of metallic tin.

About 15 chains south of the open cut, the same company are prospecting a belt of siliceous granite, originally known as Coote's Lone Hand mine. Two shafts were sunk to a depth of 65 and 50 feet respectively, and now several open cuts are being exploited. In places there is a somewhat high percentage of bismuth present, but large bunches of high-grade tin ore were recovered in the early days, and from the nature of the country rock further makes of payable ore may be expected.

The dimensions of the open cut now being worked are 16 feet by 20 feet, and the average recovery amounts to slightly over 2½ per cent. of metallic tin.

The following are the returns of tin won from the Bygoo group of mines, as published in the Annual Reports of the Department of Mines :—

1913.—From the Big Bygoo 44 tons of ore yielded 5 tons of concentrates, which returned £541, leaving 33 tons valued at £200 at grass.

Dumbrell's private lands lease (known as Dumbrell's Bygoo) gave some very rich ore, 14½ tons realising £400, with a quantity of low-grade ore at grass.

G. Coote's Lone Hand raised 600 tons, estimated at 3 per cent., all now at grass.

1914.—At Bygoo George Corner raised 58 tons, and treated 30 tons for a return of £685.

George Coote (Lone Hand mine) raised 300 tons during the year, of which 99 tons produced tin valued at £287.

1915.—Several crushings from Bygoo treated at the Southern Cross battery have been very satisfactory, and encouraged the lessees to do further prospecting.

1916.—The other producers are as follows :—Big Bygoo, £1,000; Lone Hand, £605; Dumbrell's Bygoo, £400.

1917.—At Big Bygoo the developments have been most gratifying. At the end of the year ore to the value of £6,782 had been won.

The Lone Hand produced £875 worth of concentrates. At Little Bygoo over £2,000 worth of concentrates have been produced in less than a month.

1918.—During 1918 the Big Bygoo mine yielded 1,303 tons of ore, valued at £10,121, the average value being nearly £8 a ton.

The Lone Hand mine has been acquired by W. Litton, and 167 tons returned concentrates realising £650.

Little Bygoo has produced nearly £5,000 worth of ore.

Drumlish Hill.

Within P.M.L. 113, parish of Yalgogrin, about half a mile south-west o Little Bygoo, a lode of tin-bearing material has been worked over a short length down to a depth of 40 or 50 feet, and traced on the surface for about a quarter of a mile.

Digitized by Google

The main ore body is up to 2 ft. 6 in. wide, and it is understood that good tin returns were obtained from the comparatively small tonnage of ore won. Parallel to the main lode, three veins up to 3 inches wide are exposed in the face of an open cut, over a width of about 6 feet, which also contain tin values.

On close examination it is seen that the main lode occurs along a fault plane, the permeating solutions having almost entirely replaced the normal granite on the footwall side.

The parallel veins, consisting mainly of dark coloured quartz with a little cassiterite, are considered to be due to deposition along sympathetic lines of stress.

This type of occurrence is probably identical with the lode worked by the 40-feet level at the White Crystal mine, and they are the nearest approach to true fissure veins found on the field, but will probably not extend into the porphyry as such, for it is considered that that intrusion was the cause of the faulting.

Little Bygoo, or Dumbrell's Bygoo.

This belt lies a little over a mile N.N.W. of Big Bygoo, and here three exposures of tin-bearing highly "acid" granite have been located. The largest of these covers about 2 acres, and has been opened up by shafts, trenches, and open cuts. Some rich "bungs" of tin ore were worked in the past, but the present holders are now treating low-grade ore recovered from the old open cuts and trenches.

The remaining two occurrences are smaller, and up to the present have not yielded much tin. They are not quite so acid in type, but deeper sinking might lead to satisfactory results.

In the writer's opinion all are identical with those in other parts of the Ardlethan field, and if bulk parcels of unpicked ore prove that a recovery of even 1½ per cent. of tin can be made, there appears to be a large tonnage of ore available which could be worked by open cut.

Economic handling, an up-to-date treatment plant, and an adequate supply of water are essential, however.

The present treatment plant consists of a 5-head stamper battery (750 lb. per stamp), discharging through a 14-mesh screen on to two concentrating tables, the treatment capacity being 5 tons per shift.

The plant was started in August, 1918, but owing to an inadequate water supply, very broken time has been worked.

Returns furnished by Mr. Dumbrell (part owner) are as follow:—

1918 (three months' work).—340 tons treated for a return of 5 tons 17 cwt. 2 qr. 21 lb. of 68 per cent. concentrates.

1919 (24th February to 20th March).—80 tons treated for a return of 2 tons 5 cwt. 1 qr. (wet) of 67 per cent. concentrates. (19th May to 28th June).—112 tons treated for nearly three tons of concentrates.

Digitized by Google

THE PROSPECTS OF OBTAINING AN ADEQUATE SUPPLY OF SUB-ARTESIAN WATER.

Owing to the limited rainfall in the Ardlethan district, the question of an adequate water supply is a continued source of trouble.

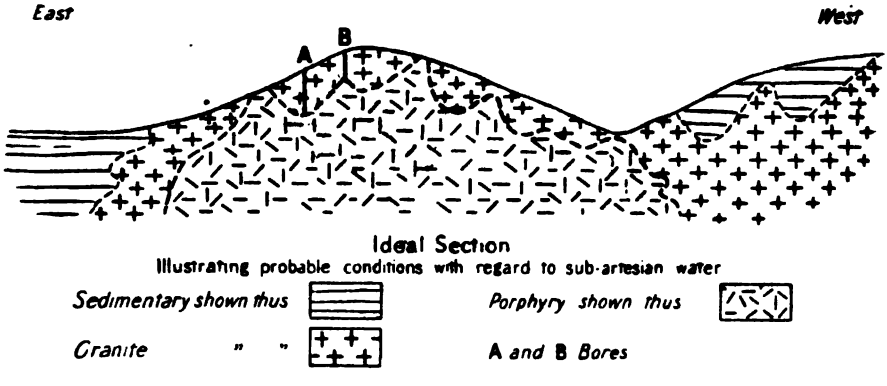
The evaporation of water from dams or tanks is high, and whilst some of the mining companies have excavated capacious tanks with good catchment areas, it is probable that if large treatment plants are to be kept running, a further source of supply would be necessary.

The presence of sub-artesian water in this area has been proved by the New Venture Company's bore, already referred to, and theoretically there is no reason why other bores should not prove successful if put down in the right places.

The site of the present bore was chosen by a divining-rod expert, and is near the top of a hill, so that without realizing the existing geological conditions, it would appear to be a most unlikely spot.

The accompanying diagrammatic section indicates the conditions existing, and should only need a short explanation.

DIAGRAM.



The porphyry is a hard dense rock free to a great extent, where visible, from pronounced joints or fissures. Its surface, although only exposed in a few places, would resemble the hills and depressions of a present-day land surface.

This is overlain largely by a somewhat porous, heavily-jointed granite, which would be very susceptible to the percolation of rain-water. The moisture thus absorbed would filter through to the surface of the underlying porphyry, and there would be a natural tendency for it to gravitate into the depressions occurring in that rock, where the loss from supage would be slight, and the overlying rock would become heavily charged with moisture.

Digitized by Google

Consequently if a shaft or borehole penetrated to one of these underground basins or valleys, the water would continually drain into the open space.

If a shaft or bore be put down at A on diagram, and strikes a basin in the porphyry, a supply of sub-artesian water would probably be obtained. On the other hand, if site B be chosen, conditions would be unfavourable.

Surface indications afford no guide apart from the actual outcrops of porphyry, and if the theories advanced be correct, prospects of obtaining a supply of water in that rock would be negligible.

This source of supply probably has its limits, for it depends upon the underground storage of meteoric water, but it should prove a valuable adjunct to the present supply, and would be repleted during wet seasons.

[5 plates; 2 full-page diagrams; 1 map folded.]

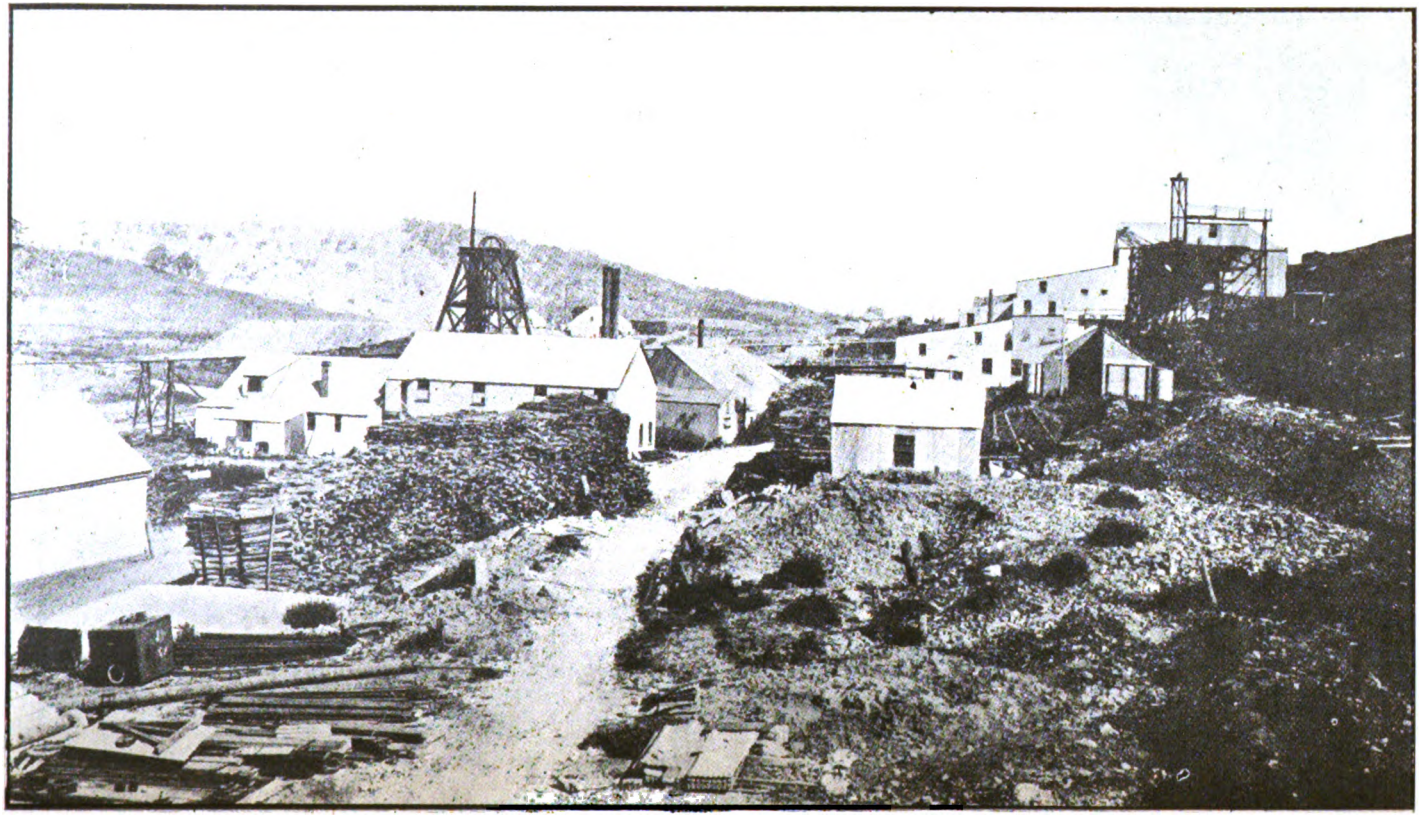
Sydney: William Applegate Gullick, Government Printer.—1919.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google



Wentworth Proprietary Gold Mine, Lucknow, N.S.W.
(Surface View.)

Frontispiece.

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, B.A., F.G.S., Government Geologist.

MINERAL RESOURCES.

No. 30.

THE LUCKNOW GOLD FIELD.

BY

L. F. HARPER, F.G.S.,

Senior Geological Surveyor.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1920.

[1s. 6d.

† 9751—A

Digitized by Google

Science Library

TN
122
.N4 A1
.A3
no. 30

CONTENTS.

PAGE.

CHAPTER I.—Introduction; Historical, and Previous References 3

CHAPTER II.—Geology 30

CHAPTER III.—Mode of Occurrence of Ore Bodies, Origin and Future Possibilities, with Suggestions as to Inspecting 37

Digitized by Google

New South Wales Geol. Surv.
4.
12-10-1923

CHAPTER I.

INTRODUCTION.

Active mining within the belt of country dealt with in the following report has been practically dormant since 1911.

At the request of the Minister, the Under Secretary for Mines, Mr. R. H. Cambage, instructed the Writer to make a geological examination of Lucknow and the surrounding district with a view of ascertaining whether there were any geological factors likely to justify a revival of gold mining in this historical and productive belt of country.

The work was undertaken with considerable misgivings, for not only has Nature hidden the larger portion of the Palæozoic or gold-bearing rocks under extensive sheets of Tertiary lava thus rendering it impossible to follow their association over any extent of country, but all the mine workings are flooded, and it is now impossible to study the nature of the gold occurrences and the associated rocks underground.

The limited exposures on the surface, which at one time would have been a considerable help to the mining geologist, are now largely covered with mullock heaps and tailing dumps.

First-hand evidence from those who worked in the mines, is, although of some help, dependent upon memory, and in many cases influenced by the personal views of the individual, whose opinions or information are based upon restricted personal experience in the mines, and not the result of a comprehensive view of the whole field. The opinions of contemporaneous mining geologists and others have been of great assistance, but here again the Writer has found much to be desired in the form of concrete evidence upon various points which would enable him to formulate theories or deductions.

In consequence of the foregoing disadvantages, it is realised that much of the present work is built on somewhat insecure foundations, and for this reason many of the views put forward can only be more or less tentative until such time as thorough prospecting work has been carried out on the lines suggested.

It is thought that the evidence available justifies the opinions expressed, and they are placed before the mining community as offering legitimate prospecting ventures, in view of the big possibilities should they prove correct.

The Writer is indebted to old miners still in the district for useful information supplied, and to Mr. W. Newman, son of the late H. W. Newman, M.P., who did so much for the Wentworth Gold-field, for having placed at his disposal a very complete set of contemporaneous newspaper clippings—which assisted greatly in the compilation of the historical portion of this report.

HISTORICAL AND PREVIOUS REFERENCES.

Despite access to Departmental publications, and a comprehensive collection of local newspaper cuttings, the writing of an absolutely reliable historical sketch of the Lucknow Gold-field is most difficult. Articles in contemporaneous papers frequently contradict one another, and were more of less incomplete, but an effort has been made in the following sketch to correlate all the information available.

Digitized by Google

The Wentworth Estate, upon which Lucknow is situated, comprised several grants to Mr. W. C. Wentworth during the year 1838, and up to the late Fifties was devoted entirely to pastoral pursuits. The name Lucknow appears to have originated from the words "luck" and "now," not after the Indian town of Lucknow, and was given to the locality by the early gold miners.

The exact date of the discovery of gold at Lucknow is somewhat doubtful. Mr. E. F. Pittman, in his work on "The Mineral Resources of New South Wales"* states that "Alluvial gold was first found at this locality [Lucknow, L.F.H.] about the year 1863, but investigations point to a much earlier date. For instance, in an issue of the *Orange Leader* for 23rd February, 1895, an article states that "mining was being carried on at Lucknow over forty years ago," *i.e.*, 1855, "under the management of Mr. E. Coombes, afterwards a member of the Legislative Council." In the same article it is stated that the field was discovered by Messrs. Agland and Townsend, who found gold on the south side of Frederick's Valley Creek, near where the "Phœnix" shaft was subsequently sunk.

Further local evidence points to the first discovery having taken place soon after gold was found at Ophir, some 14 miles north of Lucknow, in 1851.

After the Lucknow discovery, Mr. Wentworth allowed miners to work free for one month, provided the gold recovered was sold to him, or a record of the amount won furnished.

After this trial, a mine was floated in London for £50,000, but no information regarding this company could be obtained.

According to the *Western Advocate*, published on the 1st of July, 1896, a "rush" appears to have taken place to Lucknow, the estate being thrown open to miners on a monthly tenancy.

In the same issue the following appeared :—"Mr. H. W. Newman arrived in Lucknow, in 1862, with 12s. 6d. in his pocket, and in twelve months had recovered £12,000 worth of gold, mainly from the Homeward Bound Mine."

In nine months, four men were reported to have recovered £28,000 worth of gold from the Homeward Bound Mine (40 feet of ground), the total depth reached being 120 feet.

Some idea of the gold yields during this period is indicated by the following figures contained in the article above referred to. Stone from the Homeward Bound claim yielded 1 lb. of gold per ton, but work had to be abandoned at a depth of 120 feet, owing to the inflow of water.

Returns from The Snobs claim gave 15 to 20 oz. of gold to the dish (about 20 lb. of dirt); the Shamrock, 112 oz. to the ton; Golden Gate claim, 1,500 oz. from 7 tons; Spicer's claim, £50,000 in twelve months; Golden Point, £42,000 in six months; Industry Rewarded, 2,700 oz. of gold from 20½ tons; Sawyer's claim, 200 oz. from 4 bushels of dirt. From 1862 up to February, 1867, 77,156 oz. of gold were sold to the banks in Orange, realising £241,339.

In 1864 the Wentworth Estate was purchased by a syndicate of five, for £30,000, and a company floated for £40,000.

Mr. H. W. Newman appears to have soon lost the first fortune he made at Lucknow, and was compelled to seek work in other parts of the State. On returning to Lucknow some five years later (1867) he found the field practically abandoned, but shortly made fresh gold discoveries, which, brought him in £30 per week. He formed a syndicate with a capital of £2,000,

* The Mineral Resources of New South Wales, by Edward F. Pittmann, A.R.S.M., Government Geologist. Sydney, 1901, p 48.

Digitized by Google

and purchased the Uncle Tom claim for £1,800. For the first two years his efforts were not very successful, but gold was struck during the following year, and the mine was sold for £25,000. In less than a month it was resold to a company for £60,000. Mr. H. W. Newman, in addition to having an intimate knowledge and insight into the nature and mode of occurrence of the gold-bearing chutes on this field, appears to have been wonderfully lucky, and succeeded in winning a large quantity of gold from almost every mine he became interested in there. In addition to the discoveries already mentioned, he appears to have recovered £64,202 worth of gold in seven years from the New Reform Mine.

No published statement with reference to the Wentworth Gold-field, or Frederick's Valley as it was then sometimes known as, could be found in the Gold Field Commissioners' Reports prior to 1874, although as has already been shown, gold appears to have been won from there at a much earlier period. The Annual Report of the Department of Mines was first issued for the year 1875, but no mention is made of the Wentworth or Lucknow gold field. On page 3 of that publication, however, reference is made to a company in the Orange Division, having had a parcel of pyrites tested which was found to contain more than 300 oz. of gold per ton. This sample probably came from Lucknow.

Very little, if any, mining appears to have been carried out during 1876, according to the Mining Warden's report, but in 1877 the same authority states, "good stone" was being raised at Lucknow.

During 1878 mining on this field was again slack, but in 1879 the Mining Warden reported a rich find at Lucknow.

In the Annual Report for 1880, the Mining Registrar at Orange supplies a report from Mr. H. W. Newman with reference to mining at Lucknow. The only mine working appears to have been the Reform Gold-mine, under Mr. Newman's management. The deepest old workings at that time were only down 150 feet, but the Reform Mine had reached a depth of 385 feet, and the lode "looks richer, wider, and more permanent than ever."

Returns from pyrites sent from this mine for treatment at Swansea (England) as furnished by Mr. Newman, show a recovery of £4,149 12s. 3d. worth of gold, £1,800 worth of which was based on an estimate. This return was obtained from 335½ cwt., which was despatched from 1st March, 1880, to the end of that year.

During 1881 not much gold appears to have been recovered, but a large sum of money was spent in prospecting.

In the Annual Report of the Department of Mines for 1881, the following report by Mr. C. S. Wilkinson, at that time Geological Surveyor in Charge, is published :—

Appendix A.

"REPORT upon the Wentworth Gold-field, by C. S. Wilkinson, Geological Surveyor in Charge.

The Geological Surveyor in Charge to the Under Secretary for Mines.

Department of Mines, Sydney, 5 May, 1881.

Sir,—

In accordance with your instructions I have inspected the Wentworth Gold-field.

All the principal gold workings on this field are situated within portion No. 56, of 1,033 acres in the parish of Huntley, county of Bathurst, 6 miles from the town of Orange, on the main road to Bathurst, and 2 miles north-east from the Great Western Railway.

Digitized by Google

The gold deposits are of two characters—reef and alluvial, the latter having been derived from the degradation of the former. Both of these sources have yielded large quantities of gold within the last eighteen years. They were chiefly worked during the early part of that period, but latterly the alluvial deposits have not been worked, and at present only the Reform Gold Mining Company is raising stone from the reefs.

This comparative cessation of mining operations is, I am told, attributable not to the absence of payable gold in the deposits, but to the following facts :—Firstly, that the deposits have been worked as far as was possible with the ordinary appliances; secondly, that in the case of the reefs below the water level, the oxidised ores passed into undecomposed sulphurets which were difficult of treatment; thirdly, that the terms upon which the land was leased from the proprietor of the estate were not such as to enable the ordinary miners with small capital to accept them; and lastly, that where this difficulty was overcome, mismanagement of the mining works, owing chiefly to the peculiar mode of occurrence of the reef-stone, caused cessation of operations.

The reefs occur at the junction of serpentine and hornblendic felsite, the latter in places passing into diorite. Along this line of junction is what the miners term the lode, which, at the surface, is a fissure 6 feet or more in width, extending in direction S. 50° E. (or nearly south-east and north-west) for a distance of 50 chains. It is filled with a red, sandy, ferruginous clay, containing hard siliceous accretions of irregular shape, locally termed "clinkers." This lode dips to the north-east at an angle of about 65°, though in some places it is nearly vertical. The hornblendic felsite forms the footwall and the serpentine the hanging wall. In the felsite, at varying distances along the lode, are quartz veins, from a few inches to 6 feet thick, coming in from the west and abutting against the lode which they appear to follow down, and form irregular quartz pipes or shoots dipping diagonally along the lode towards the east. These veins have only been found to contain payable gold where they occur in the lode and form the shoots. The old workings upon sixteen of these shoots were pointed out to me by Mr. H. W. Newman (the present manager of the Reform Gold Mine), who has witnessed the opening of nearly all the mines on this lode. These old workings had either fallen in or were full of water, so that I could not examine them beyond noting their positions at the surface, where the lode appeared to possess more or less the same character throughout.

In the Reform Mine the vein or shoot known as the Uncle Tom vein is being worked at a depth of 387 feet. I examined it at this level and found the vein 5 feet 6 inches wide and extending along the junction of the serpentine and felsite for a length of 43 feet. The walls of the "lode" are here nearly vertical, but the vein or shoot of ore dips easterly at an angle of about 50°. The vein stuff consisted of quartz, calcite, felsitic rock, and serpentine, with veins and irregular masses of arsenical and iron pyrites disseminated throughout the mass, which assumes a serpentinous character as it approaches the hanging wall of serpentine, and in this part of the vein occurs the greater portion of the rich gold-bearing arsenical pyrites. At this level the sinking is nearly dry. The whole of the vein stuff is taken out and sent to the surface, where it is

Digitized by Google

sorted—the pieces, consisting almost entirely of pyrites, being hand-picked and packed just as they are, in barrels for transmission to Swansea, whilst the rest of the stone is put through an eight-stamper battery and over quicksilver—and blanket tables, by means of which most of the free gold is obtained and the pyrites collected. These pyritous tailings are then also shipped to Swansea. Mr. Newman informs me that the pyritous stone sent to Swansea gives returns of from 60 to 80 ounces of gold per ton. One sample of 3¼ cwt. gave at the rate of 103 ounces of gold and 21 ounces of silver per ton. The free gold obtained from the crushing battery averages from ½ ounce to 1 ounce per ton, and the blanketings from 7 ounces to 16 ounces of gold per ton.

The Uncle Tom vein has continued without a break from the surface to the depth at which it is now worked, but the upper portion, also rich in gold, consisted of the above mentioned ferruginous sandy clay and clinkers, which are the result of decomposition.

I am informed that the Phœnix vein (which has been worked to a depth of 200 feet) and the Homeward Bound vein at a depth of 500 feet (which is the deepest level yet attained on the field) possess characters similar to those of the Uncle Tom vein at its lowest level; and that the other thirteen veins which were worked, some of them with very rich returns, to various depths (the deepest shaft not exceeding 180 feet) also exhibited the same decomposed ferruginous character until the water level was reached, when the sulphurets made their appearance and the gold became consequently more difficult of extraction.

The upper or decomposed portion of the lode contains numerous minute crystalline grains of magnetite, which has probably been derived from the serpentine of the hanging wall; for this rock is seen to contain considerable quantities of magnetite in thread-like seams disseminated through it. Between the veins the intervals in the lode do not contain payable gold.

From the nature of the bounding rocks, and the mode of occurrence of these veins, I am of opinion that their gold-bearing character will not diminish, as they are followed deeper; though the yield may be expected to fluctuate occasionally, yet the rich pyritous stone obtained at the lowest levels in the Reform (387 feet), "Phœnix" (200 feet), and "Homeward Bound" (500 feet) mines, shows the persistent richness of the veins, and this receives further confirmation when we consider that above the present surface probably many hundred feet of rock, with the veins traversing them, have been removed during the erosion of the valley in which this gold-field is situated.

This is a very important consideration, for it gives assurance that these veins, or shoots, may be profitably worked to greater depths; but owing to the limited *horizontal* extent (from 20 to 50 feet) of each shoot along the lode, they will each probably have to be mined separately, somewhat after the system now so economically carried out in the Reform Mine under the able management of Mr. Newman.

About 200 yards distant from this lode, and running nearly parallel with it, is a large quartz reef 6 feet thick; it has a brecciated appearance, due to the reef consisting of a very close network of veins. It occurs in hornblendic felsite, and the quartz is of a similar character to that forming the veins in the felsite adjoining the lode above described. It is probably one of the same system of veins. I am informed that this

Digitized by Google

large reef has only been prospected to a depth of about 40 feet. It was found to contain pyrites, but no gold was visible. I think, however, that it should be further explored, and especial attention given to any portion of it, or branch veins from it, which may be found to come in contact with, or traverse the belt of serpentine which lies between it and the present known auriferous veins. For from close examination which I have made of this serpentine, and of the manner in which the gold and pyrites occur in the Uncle Tom vein, I am of opinion that the vein fissures have chiefly derived their metalliferous contents by infiltration from the serpentine formation.

Before concluding my remarks upon this important gold-field, I would here refer to its auriferous alluvial deposits.

These are of two ages—the one of recent formation forming the surface soils and alluvial flats, which have been worked out; and the other of much older date, and consists of coarse gravel which once formed the beds of the streams which in the Tertiary Pliocene period drained the surface of this country, and were afterwards covered over by volcanic rock.

One of these ancient river beds or leads known as the Chapel-hill lead, has been worked for nearly ½-mile along its course, and several thousands of tons of gravel or wash raised, yielding, I am told, from 1 to 5 ounces of gold per load or ton. This lead proved rich, as might have been expected, seeing that its channel had been eroded directly across the "lode" or line of gold-bearing veins, and it had therefore received all the gold liberated and swept down from these veins.

But I would especially draw attention to what appears to be another lead, also running across the same line of reefs, at a point about 22 chains from where the Chapel-hill lead crosses. The course of this lead is indicated by a flow of basaltic lava, about 3 chains wide where it crosses the line of reefs, and it then extends, in a south-westerly direction, as if to junction with the other lead. The character of this lead has not yet been proved, but some years ago Messrs. Newman and party sank a shaft on the side of it, and report to have found very promising indications—drift, fossil wood, &c., such as were found in the "Chapel-hill" lead, but they were unable to continue their prospecting, owing to the great quantity of water met with. This lead should certainly be tested, and this might easily be done by sinking a shaft through the basalt a few chains to the south-west from where it crosses the line of reefs.

Should it, as I anticipate, be found payable, it will be a discovery of great importance to this district; for as it forms one of the ancient systems of drainage channels, it must extend for a considerable distance and be connected with other branch leads, and will therefore afford a field for a large number of miners.

I have, &c.,

C. S. WILKINSON, F.G.S.,

Geological Surveyor in Charge.

In 1882 the Mining Warden reported that "Lucknow continues to go ahead, the shareholders of the principal claims appear satisfied with the results." Again, in 1883, the same authority states that "Lucknow maintains its reputation as a gold producer."

Digitized by Google

The following information was supplied by Mr. Warden J. T. Lane, P.M., Orange, in 1884, and was published in the Annual Report of the Department of Mines for that year:—

Lucknow.—This old field is coming again to the front. The New Gold-Mining Company (Limited) is steadily, but I believe, surely, developing its richness. I personally inspected the whole operations a few weeks ago, and I do think the economy manifested cannot be surpassed, the whole cost for six months being under £2,500, whilst the "output" is some £7,500, the product of seventeen men's labour, two engines, two shafts (300 and 200 feet), and a twelve-stamp battery buddle. The 300-feet shaft is to be sunk 100 feet deeper, another level driven, and facilities for crushing longer hours. The company is already paying a dividend.

Mr. Newman's success *re* this company has induced an English syndicate to purchase the adjoining property, known as Frederick's Valley Gold Mining Co. (Limited), London, and preparations are now being made to work it on an extensive scale. They have a 25-horsepower engine, with a 30-horsepower boiler, which will drive the ten head of stampers recently erected. A Munday patent buddle, improved by Mr. Newman upon the same principle as the one working at the "Reform," will retain the whole of the ore in a concentrated state within the first 18 inches. The same engine will also do the pumping from the 300-feet shaft, known as Golden Point shaft. A 10-horsepower engine is erected to do the winding.

A tram-road 700 feet long has been erected, connecting a shaft 200 feet deep, known as the Shamrock, with the battery. At this shaft the company purpose erecting an engine, with pumping gear, and if necessary, crushing appliances, similar to those at the Golden Point shaft.

The prospects of this field are considered very encouraging. In the early days many rich veins disappeared and have not been seen since. The original Golden Point vein yielded to the shareholders the enormous sum of £50,000 in nine months, Spicer's 80 feet, £42,000 in six months; Golden Gate, 80 feet, £35,000 in eight months; Shamrock, 80 feet £30,000 within two years; Crinoline, 20 feet of ground, £20,000 in eighteen months; Snobbs', 380 feet, £20,000 within one year, besides several smaller returns, making in all a large round sum within two years. The pyrites veins have not as yet been opened up. Alluvial gold is being found upon the property in sufficient quantity and it is thought to keep the battery going whilst the veins are being opened.

This property is under the able management of Mr. H. W. Newman, who is a large shareholder, and who informs me that English capital to any extent is available for *bona-fide* mining speculations in the Colony.

I have been more lengthy in my remarks *re* Lucknow gold-field for two reasons—the presumed relationship existing between it and the other gold-fields in this neighbourhood, and the belief that Mr. Newman's skill and perseverance deserve some special mention.

In 1885 the Mining Warden reported that active mining was in progress at Lucknow, and that the Frederick's Valley Gold Mining Company were prospecting by means of the diamond drill, which was then down some 240 feet in serpentine.

Digitized by Google

In the Annual Report for 1886 is published :—

> Lucknow is promising great things. The New Reform are adding to their machinery, with the view of extending operations; and they purpose sending their bonanzas straight to Germany in the state in which they are blown out. The fact of this company paying £15,750 dividends, after sinking main shaft 100 feet deeper—in all 400 feet—and clearing all expenses in connection with machinery, pumping, &c., &c., during the past two years, says wonders. When the new stampers are completed there will be twenty heads. The financial position of the company favours the working of the mine in the most efficient manner. £5,000 worth of ore is now in transit, against which no advance has been taken.
>
> The Jack Ass Flat Gold Mining Company are down 150 feet with the new shaft, and the promises are very encouraging.

In the report for 1887, information supplied by Mr. Newman shows that £16,400 worth of gold was recovered during that year, £15,326 of that sum representing the return of the New Reform Gold Mining Company (Limited). Two other companies at Lucknow are referred to, namely, the New Reform Pups, and the Jack Ass Flat Gold Mining Company, but are described as only prospecting, the depths reached respectively being 300 feet and 150 feet, "the indications in both cases being considered satisfactory."

In the Annual Report for 1888 the following information from the Mining Registrar, Orange, is supplied. The New Reform Gold Mining Company had reached a depth of 525 feet, the lode varying in width from 1 foot to 20 feet. About 3,000 tons of ore were raised during the year, valued at £6,484. The New Reform Pups were down to a depth of 225 feet, on a lode 3 feet wide from which about 250 tons of ore had been raised, but not gold return is published.

In the report for 1889 information from the Mining Warden points to a pronounced slump in gold mining at Lucknow. The property of the New Reform Gold Mining Company was for sale, having been idle for the previous six months. The New Reform Pups had been sold to Mr. F. L. Gardner, of Sydney, in addition to other property in the neighbourhood.

No mention is made of the Lucknow field in the Annual Reports for 1890 and 1891.

Mr. F. L. Gardner apparently first began to secure large interests at Lucknow in 1889, in conjunction with Mr. H. W. Newman and others, and 1,033 acres of the Wentworth Estate were finally secured during the following year.

The price paid was £50,000, and a move was at once made to bring about a big English flotation.

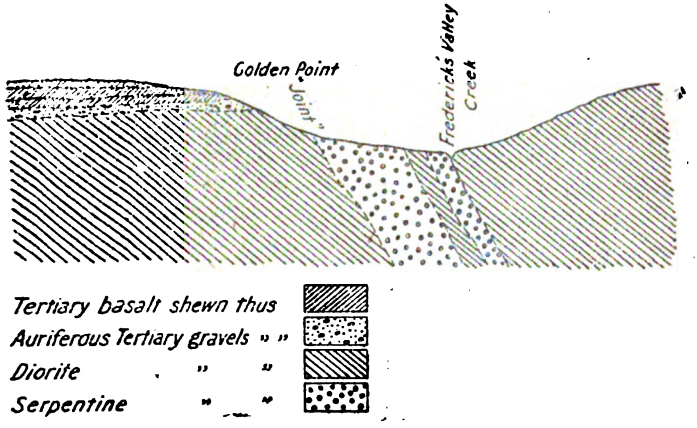
About the middle of 1890, Messrs. Caird, Maxwell & Co., who were apparently interested, instructed Mr. Henry Rosales, F.G.S., Consulting Mining Engineer, to report on the property. Through the courtesy of Mr. W. Tarleton, for some time Secretary to the Wentworth Gold Fields Proprietary Company, Limited, the Writer had an opportunity of studying this report. In addition to its historical interest, it touches on several important points discussed in the present work, and has been freely extracted from.

Mr. Rosales had apparently examined the Lucknow mines on a previous occasion, when they were held in part by the Frederick's Valley Gold Mining Company, but owing to this Company refusing to consent to certain vital points, such as area and time for exploring and developing the mines at a depth, &c., Mr. Rosales' report was unfavourable.

Digitized by Google

This difficulty appears to have been overcome by the purchase of the Company's holdings in 1889, and the subsequent report was highly favourable. It was pointed out in the report that a large amount of capital would be required to develop the mines on account of the necessary extent of "prospecting work," and that "for some time the mine will be a progressive one."

At this period the nomenclature of rocks was not based on the finer distinctions adopted at the present time. The local term for the earlier Palæozoic rock was "diorite," but Mr. C. S. Wilkinson, at that time Government Geologist, had adopted the term hornblendic felsite. Mr. Rosales made use of the local name, at the same time referring to Mr. Wilkinson's determination, and in extracting from his report that name is used. Whilst attention is devoted mainly to the south-easterly and north-westerly belt of serpentine on the left hand bank of Frederick's Valley Creek, mention is made of "several outcrops of intrusive serpentine rock," also "there is a short outcrop of serpentine in the bed of the creek not far below the large dam." Reference is made to the a sketch plan and section, but copy could not be obtained. Mr. Rosales' conception of a cross section opposite the Golden Point as reconstructed from the text of his report, is apparently as follows:—



The following information and suggestions contained in the report under review have not, so far as the writer is aware, been referred to by other writers, and as it throws some light upon geological occurrences at Lucknow no longer exposed, it is quoted in full:—

"The dioritic rocks in the neighbourhood of and in the vicinity of the contact line, locally called "joint," is traversed by a number of quartz reefs and masses which vary in their course between north-east and south-west and north-west-south-east points of the compass, for instance, the massive reef already alluded to, the bearing of which is approximately north-west–south-east, and another quartz outcrop (marked on the sketch plan) the strike of which is about north-east–south-west, whilst most of the contact line strike on an average 15 west of north, and those to the east of the serpentine belt along the main road about the same number of degrees to the east of north.

Digitized by Google

These latter quartz veins, possibly may join on to the eastern wall of the serpentine belt in a similar manner as and with a similar result to those from the north-west, which abut on to the contact line (although it is so far, only along the western wall of this main serpentine outcrop, in contact with the diorite rocks, that the metalliferous veins and shoots have been found) without extending or into the belt of serpentine rock. It is a remarkable feature all along the contact line on the surface, that wherever a quartz vein (although barren) strikes the "joint" between the diorite or serpentine, that it there and then comes into contact with a metalliferous calcite vein. These facts, it is fair to infer, go to show (all the quartz veins being abruptly broken off) that the serpentine is of an intrusive character, and that it was in the breach following from below, along the "contact line," the tract of the fractured and broken up quartz veins (cracks and fissures), that the auriferous and metalliferous calcite veins were deposited from probably partly thermal mineral springs, continuing active for a lengthened space of time at the end, and as a sequel to the intrusion of the serpentine into the diorite country. Thus may be explained the sudden termination of the quartz when in contact with the calcite veins, that the former only contains gold or metallic ores at the junction with the latter, the peculiar nature of the formation of the pipe-veins in this instance, and consequently at the same time the cause of the existence of the extent of "dead ground" between them along the close joint, and also the formation of some vein from 20 to 40 along the line of contact, and others extending 20 to 50, into the diorite."

At the time this report was furnished, it was estimated that the ground opened up in various mines, on the course of the veins, totalled "a distance of 3,000 feet in round numbers."

It is pointed out that "the total gross value of the gold realised to February of this year (1890) has been £67,670." The report does not make it clear what mines contributed to this amount, nor the periods embraced, but it was apparently from 1881 to 1890.

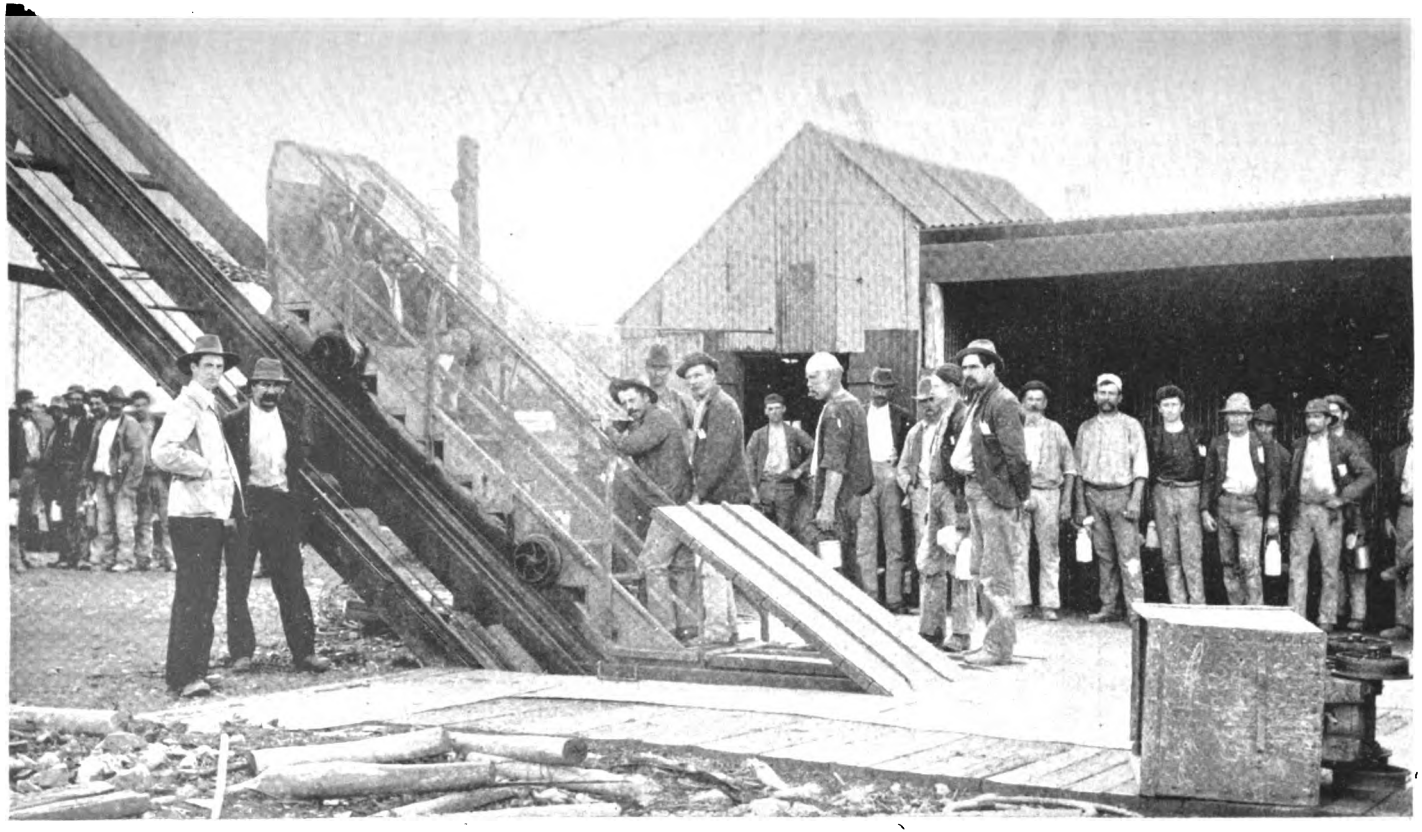
Mr. Rosales then goes on to describe the metalliferous character of the veins, the value of the ore, the mining plants, underground workings, and reduction machinery.

Amongst suggestions as to future porspecting work, the desirability of prospecting the country south-east from the Shamrock shaft is pointed out. As a result of the writer's recent examination of the field, he is strongly of the opinion that if mining is to be revived at Lucknow, prospecting must be concentrated in that direction, as offering the best prospects of success.

Before concluding his report, Mr. Rosales points out that, "It is not to be denied that a large amount of 'dead work' will be required to be undertaken to test the ground, and that only a small output comparatively may be obtained, yet—and it should not be overlooked—the rich portions of the veins have lately more than counterbalanced the expenditure incurred in exploration."

Largely as a result of Mr. F. Gardner's efforts, supported by Mr. Rosales' report, the Wentworth Goldfields Proprietary Company (Limited) was floated in London in November, 1890, with a capital of £500,000 in £1 shares. The shares consisted of 150,000 priority shares, and 350,000 ordinary shares, the latter to receive no profit until dividends aggregating 100 per cent. had been paid on the priority shares. No details are available as to the acutal cash paid to the vendors, the number of shares issued as fully paid-up, nor the proportional allotment of the priority shares.

Digitized by Google



Changing Shifts, Wentworth Proprietary Gold Mine, Lucknow, N.S.W.
(Showing Man-cage.)

[*To face page* 12.]

Digitized by Google

Digitized by Google

The following information was obtained from the Annual Reports of the Company, kindly lent by Mr. Tarleton :—

"The company started operations in March, 1891, a Local Advisory Board being appointed in Sydney to administer local control. Before the close of the year the London Board appear to have been dissatisfied with the local board, and sent Mr. H. A. Thrower, of the London Board, out to Australia to investigate matters. As a result of his visit, the Advisory Board was deposed, and Mr. W. J. Collins was appointed Consulting Engineer with Mr. W. A. Irwin as General Manager." The change appears to have been beneficial for, according to the Director's report, "from the day when Mr. Collins took control, the results of the change began to show themselves." Practically the whole of the profit shown in the first annual report of the company was earned during the last six months prior to December, 1892.

The table given on page 16 shows that in a very short time the Company started to pay dividends, and up to December, 1898, continued to do so, the total amount received in dividends by the shareholders being £300,000, earned in less than seven years.

According to the Mine Manager's first annual report, the new main shaft was commenced during 1892 in diorite, and passed into the serpentine at 260 feet.

Gold to the value of £26,729 13s. 2d. was recoveerd up to the 30th September, 1892, and in addition to the expenditure of a large sum in development work, a new 20-head stamper battery was completed, in addition to the four batteries, totalling 48-head of stampers already on the ground at the time of the purchase.

About the middle of 1892 two subsidiary companies were formed, namely, the Aladdin's Lamp, and the Amana, which are here dealt with in order after the parent company.

During 1893, Mr. W. A. Irwin, General Manager, retired, and Mr. F. M. Drake took his place.

From the annual report of the Directors it is learnt that no large new finds of rich ore had been made, but the previous finds continued to yield ore.

Great improvements had been made in the mine equipment and treatment plants, and the new main shaft had reached a depth of 598 feet by the end of the year. During the year 4,226 feet of development work was carried out, and £29,514 14s. 2d. worth of gold recovered. In 1894 Mr. Collins applied to be relieved of his position as Consulting Engineer, owing to failing health, and a new superintendent was being selected. During the year the new main shaft reached a depth of 828½ feet, and drives from the 600 and 800 feet levels were pushed ahead, but "work was nearly all in the nature of development or dead work."

The mill was kept supplied with ore from the Homeward Bound, Spicer's, and Phœnix veins. Attention was also paid to the alluvial ground, but results do not appear to have been very encouraging.

During the year 3,458 feet of development work was carried out, and 13,030 oz. of gold recovered, which realised £44,530 6s. 6d.

1895.—Mr. C. G. Warnford Lock was appointed Superintendent, and took charge about the middle of the year. The Directors' report states that the year 1895 was the most successful in the Company's history, the total gold yield having been 60,479 oz., which realised £232,457 6s. 10d. This large

Digitized by Google

result was mainly due to the yield from an ore body discovered on the 500 feet level in the Phœnix ground, and although this deposit was almost worked out during the year, other discoveries were being made.

It was pointed out by the Chairman of Directors that in accordance with the original terms of issue, ordinary shares were to receive no profit until dividends aggregating 100 per cent. had been paid on the priority shares (150,000), and that this preferential payment of 20s. per share had been completed in May of that year, subsequent to which all shares participated in dividends.

During the year 4,837 feet of development work was carried out, the new main shaft having reached a depth of 883 feet. As it was in "hard diorite, and the joint had been passed through and been left 400 feet above," sinking was discontinued.

The Superintendent in his report draws attention to the importance of treating the accumulated tailings. He pointed out that the value of these tailings as determined by the assay of a large number of systematically-taken samples, was as follows :—

Coarse	·3319	oz. of bullion	per dry ton.
Slimes	·4964	,,	,,
Slimes and middlings	·3750	,,	,,
General average	·4011	,,	,,

From the above it was considered that 25 per cent. should be deducted as irrecoverable, "thus making the average available value about 6 dwt. per ton, worth 3s. 6d. per dwt., or 21s. per ton. Mr. Lock goes on to point out that there should be a realisable sum somewhere between £10,000 and £15,000 in the tailings dumps.

1896.—The Directors in their annual report for 1896 state that the total gold output for the year was 16,524 oz., valued at £62,642 6s. 5d. The superintendent reported that 5,847½ feet of development work had been done during the year, in addition to 141½ feet of diamond drill-boring.

1897.—In the Annual Report published for 1897, 13,744 oz. of gold was stated to have been recovered, but no dividend was declared.

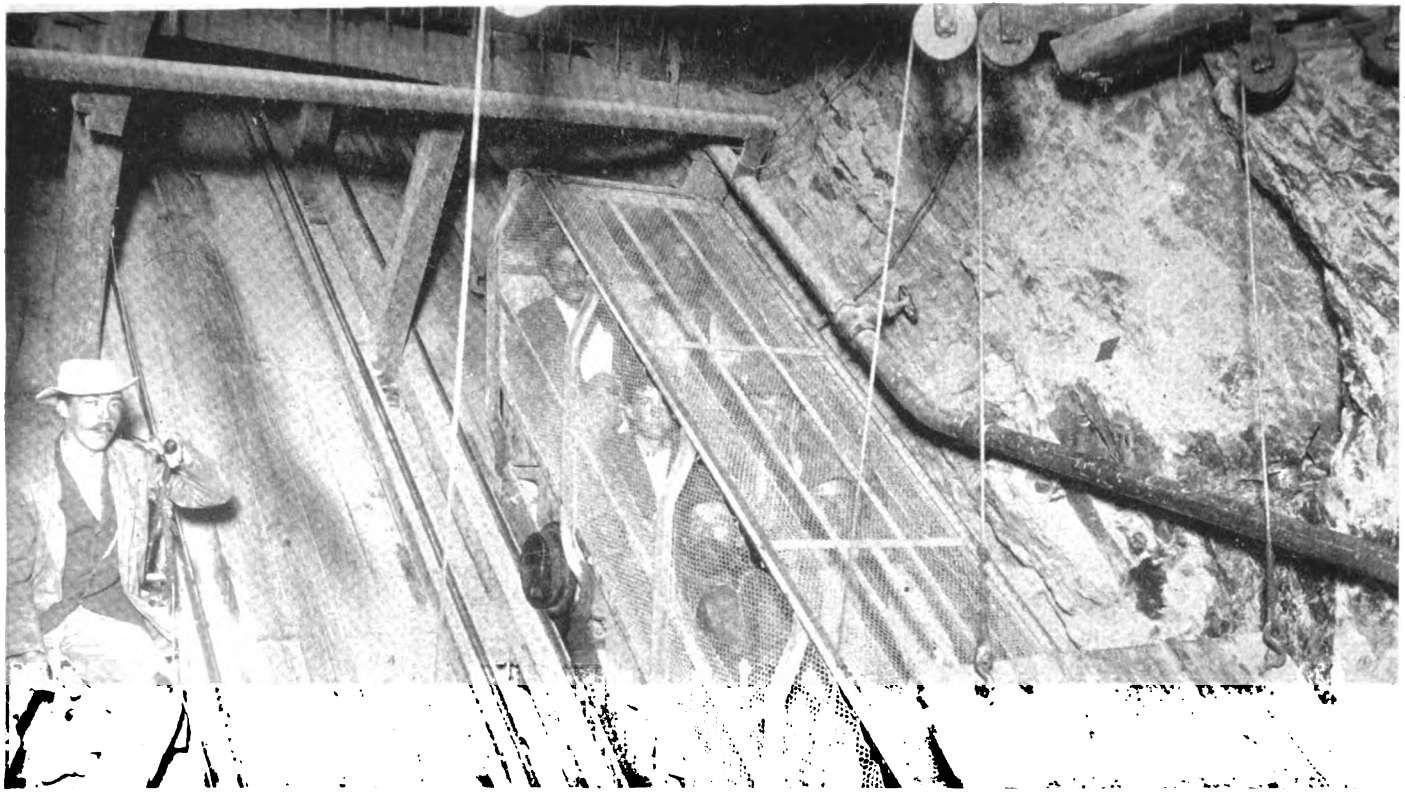
The Superintendent, in his report, shows a total of 4,435 feet of development work and points out that the slight falling off compared with the previous year was due to a strike amongst the miners.

1898.—The Directors reported a recovery of 13,572 oz. of gold during the year, being a slight falling-off from the previous year, but a dividend of 1s. per share was declared. According to the Superintendent's report 3,310 feet of development work was carried out during the year in the "joint" workings, and 152 feet of tunnelling in the Tertiary deep lead.

Work on the Welcome vein appears to have been the most important and remunerative during the year, and further extensive prospecting to locate this vein at the 800 feet level was carried out. Favourable developments took place in the 700 feet level from the new main shaft, which was then in 1,000 feet to the south-east.

The alluvial ground was being vigorously prospected during the year, with encouraging results. Experimental work with a view to successfully treating the tailings was being carried out by Mr. H. Watson, F.I.C., but a treatment plant had not been adopted.

Digitized by Google



Wentworth Proprietary Gold Mine, Lucknow, N.S.W.

(Man-cage passing plat.)

[*To face page* 11]

Digitized by Google

Digitized by Google

1899.—The Directors' report for 1899 was delayed until May, 1900, and appears rather pessimistic. The Mine Manager, Mr. A. R. Canning, resigned in December, 1898, and the Superintendent, Mr. C. G. Warneford Lock, saw fit to "emphasise his previously recorded fears of the decadence of the ore-bodies," at the same time intimating his desire to relinquish the position of Superintendent. He resigned in August, 1899, and Mr. R. Canning, Chief Engineer, was appointed Acting Superintendent.

In November, 1899, Mr. Lock attended a meeting of the Directors in London, and as a result of the conference, Mr. S. Herbert Cox was selected as an independent expert to report on the Wentworth Proprietary and Aladdin's Lamp Companies. On receipt of this report, a fusion was brought about, and the capital of the parent company was increased by a further £150,000, the whole of the assets of the Aladdin's Lamp Company being taken over by the Wentworth Proprietary in exchange for 100,000 ordinary shares, the balance, 50,000, being held in reserve.

Up to the 30th September, 1899, £27,219 9s. 3d. worth of bullion was disposed of, and the estimated value of shipments was £9,745.

£25,878 10s. 8d. was brought forward from the preceding year, and after deducting all expenses from the total, £22,558 13s. 8d. remained as profit This shows a loss on the total returns for the period ending 25th May, 1900, of £3,319 17s.

The Superintendent in his report for the year ending 23rd September, 1899, states that 2,945 feet of development work had been carried out, in addition to 410 feet of tunnelling on the Tertiary lead.

Values were becoming negligible in all the veins then existing, and many of the rich veins in the upper levels had split up or pinched out.

Prospecting in the alluvial ground proved disappointing, and work was abandoned.

The conclusions arrived at by the Superintendent, as published in his final report, are as follow :—

"That before the end of the year we had exhausted our known supplies of ore, with the bare exceptions of the "Shamrock" veins at the south-east end of our workings, and some unimportant remnants such as a pillar of the Surprise vein on the 400, and a similar block of the Cuddy vein, 500.

That our extensive prospecting, which at one time promised well, has finally resulted in our drawing blanks at every point. Throughout the history of the mine, as we have gained in depth, a number of the lesser veins, which were highly productive in the upper levels, have utterly ceased. This, in itself, though an unfavourable feature, was not regarded too seriously so long as the main veins held good, and no notable change occurred in the formation. Now we have to admit that the great Welcome vein ceases to be gold-bearing at about 750 feet, and has yielded nothing to our explorations for the next 150 feet. The Surprise vein virtually terminated at 600 feet, and has been fruitlessly followed for 200 feet more. The Homeward Bound was barren at a little below 600, and even at 1,000 shows no improvement, but rather a greater weakening.

That generally throughout the mine at depth the serpentine rock, which has in every case been closely associated with auriferous bodies on this field, is no longer present."

Digitized by Google

The following returns of bullion realised on and dividends paid are available with regard to the Wentworth Gold-fields Proprietary Company (Limited) from the time work was started (March, 1891) to the cessation of active mining operations during 1900 :—

Value of Bullion Recovered.

	£	s.	d.
Up to 30th September, 1892	26,729	13	2
" " 1893	29,514	14	2
" " 1894	44,530	6	6
" " 1895	232,457	6	10
" " 1896	62,642	6	5
" " 1897	51,554	11	4
" " 1898	50,824	3	10
" " 1899	27,219	9	3
Value of ore shipments afloat on 30th September, 1899	5,603	18	9
	£531,076	10	3

The following is a table of dividends paid during this period :—

	£
27th December, 1892—4s. on Priority shares	30,000
26th January, 1893—6s. " "	45,000
24th January, 1895—2s. " "	15,000
3rd April, 1895—3s. " "	22,500
2nd May, 1895—5s. " "	37,500
12th July, 1895—1s. on all shares	25,000
9th August, 1895—1s. " "	25,000
13th December, 1895—2s. " "	50,000
14th April, 1896—1s. " "	25,000
10th December 1898—1s. " "	25,000
	£300,000

No final figures are available with regard to the operations of this company, but it would seem that the remaining available funds were invested in other mining properties in the State of New South Wales, with disastrous results.

As an individual company and gold producer the Wentworth Gold-fields Proprietary Company (Limited) appears to have ceased to exist early in 1900, after a life of about nine years, during which period gold to the value of £531,076 10s. 3d. is on record as having been recovered, very little stoping having been done below the 700 feet level.

There is no doubt that this amount would be materially increased if returns were available of all the gold stolen during this period.* Moreover, although returns are not available, it is well-known that tributors recovered a large quantity of gold subsequent to the company abandoning operations.

Finally, there is the value of gold recovered from the tailings, a very large proportion of which was treated in after years, some of the dumps more than once. According to Mr. Lock's estimate in 1895, there was probably about £15,000 worth of recoverable gold in the tailings available at that time.

For the following two years mining at Lucknow appears to have been at a very low ebb, but during 1902, an amalgamation between the principal mines was brought about, and work was resumed under the superintendence of Mr. H. W. Newman, M.P.

* See Annual Reports of the Superintendent, 1897, p. 25 and 1898, p. 21.

Digitized by Google

Wentworth Proprietary Gold Mine, Lucknow, N.S.W.

[*To face page* 16.] A View Underground.

Digitized by Google

Digitized by Google

THE ALADDIN'S LAMP GOLD MINING COMPANY LIMITED.

This Company was formed in June, 1892, as a subsidiary to the Wentworth Company, and in addition to 20 acres of ground secured from that company, 10 acres, held under lease by the Jackass Flat Gold Mining Company (Limited), were also purchased. The capital of the company was £100,000, the price paid to the Wentworth Company being £70,000, namely, £5,000 in cash, and £65,000 in fully paid shares; and to the owners of the Jackass lease, £5,000 in cash, and £15,000 in fully paid shares, thus leaving £10,000 (fully subscribed) for working capital.

No information is available as to previous work done on this property or the quantity of gold recovered, but the three principal veins included in the property were the Welcome, Surprise, and Jackass.

According to the first annual report of the directors (to 30th September, 1893), the Jackass shaft had been sunk to below the 400 feet level, and the 300 feet level extended south-east to the boundary to connect with the Wentworth Company's workings.

The Phœnix shaft was also in existence at that period, reference being made to connecting it up at the 200 feet level.

The report points out that the wonderfully rich brown vein was practically exhausted of all its known oxidised ore (probably down to about 150 feet).

A 10-head stamper battery was at work, and a 6-head battery was also on the ground, but apparently worn out.

Most of the gold recovered by the Company up to September, 1894, appears to have come from the Jackass shaft workings at the 300 feet level, which was extended south-east for 648 feet, and connected with the Wentworth Company's workings.

Satisfactory developments continued to take place in the deeper levels, particularly at the 500 feet, and, as will be seen from the following figures, a vigorous development policy was carried out :—

Year ending 30th September,	1894	1,870½ feet of development.
" "	1895	1,368½ " "
" "	1896	3,115 " "
" "	1897	2,260½ " " and 148 feet with diamond drill.
" "	1898	923½ feet of development, and 109½ feet with diamond drill.
" May,	1900	990½ feet.

The deepest point reached by this Company was between 900 and 950 feet in a winze on the Jackass vein, but very little stoping appears to have been done below the 500 feet level.

Tables of gold recovered and dividends paid by the Company are as follows :—

Gold Returns.

		£	s.	d.
From June, 1892, to September,	1893	50,405	14	0
To September,	1894	39,520	8	6
"	1895	89,037	11	5
"	1896	56,210	19	9
"	1897	39,477	13	5
"	1898	24,981	6	10
"	1899 (including ore afloat)	33,406	9	3
"	1902	5,514	18	11
		£338,555	2	1

Digitized by Google

Statement of Dividends.

			£
11th August,	1892—2s. per share		10,000
15th September,	1892—1s.	,,	5,000
26th November,	1892—1s.	,,	5,000
9th February,	1893—1s.	,,	5,000
28th January,	1894—1s.	,,	5,000
29th February,	1894—1s.	,,	5,000
29th March,	1894—1s.	,,	5,000
28th April,	1894—1s.	,,	5,000
16th January,	1895—1s.	,,	5,000
21st March,	1895—1s.	,,	5,000
16th May,	1895—1s.	,,	5,000
19th July,	1895—2s. 6d.	,,	12,500
25th September,	1895—2s. 6d.	,,	12,500
13th December,	1895—3s.	,,	15,000
16th December,	1896—6s.	,, (interim)	30,000
,,	1896—2s.	,, (annual)	10,000
	1897—4s.	,, (interim)	20,000
	1897—1s.	,, (annual)	5,000
	1898—2s.	,, (interim)	10,000
			£175,000

After paying the last dividend in 1898, a balance of £10,612 18s. 9d. profit still remained in hand.

The Superintendent in his report for the twelve months ending 30th September, 1898, pointed out that prospects were not encouraging, and at the directors meeting a proposed amalgamation with the Wentworth Proprietary was argeed to.

In 1900 the property was visited by Mr. S. Herbert Cox (of Messrs. Bainbridge, Seymour & Co., London), who furnished a lengthy report to the directors, the following statement appearing in his general conclusions :—

" We consider the most important deposits that have been proved within your boundaries have been practically worked out, and pending further developments outside, we think you will be well advised to revert for the time to the prospecting stage upon a small scale."

Subsequent to Mr. Cox's visit, the suggestions submitted as to prospecting, &c., were carried out, but according to the Directors' report, submitted on the 17th December, 1902, " these researches have not been successful. . . . Sufficient low-grade ore was, however, recovered to pay working expenses up to the beginning of 1901. Since then the veins gradually gave out and it became necessary to cease work."

The mine was shut down in December, 1901, but subsequently was let on tribute, and several parties recovered a considerable amount of gold.

The expense of keeping both the Aladdin's Lamp and Wentworth Proprietary Company's mines in proper working condition does not appear to have been justified however, and it was not long before all the workings were allowed to become flooded. It is estimated that there are 13 miles of levels, drives, cross-cuts, winzes, &c., in the old workings at Lucknow, all connected, and these are all now full of water.

According to Mr. C. G. Warnford Lock, the accumulated tailings from the Aladdin Mine totalled at least 20,000 tons, with an average assay value of not less than 5 dwt. of fine gold, or an aggregate value of £20,000. Most of these tailings were subsequently treated by the Australian Mining and Gold Recovery Company and others with satisfactory results.

Digitized by Google

The Amana (Wentworth) Company.

Shortly after the formation of the Aladdin's Lamp Company, the Amana Company was formed on similar lines; the ground, held under a twenty-one years' lease, comprising 30 acres, immediately adjoining the Aladdin's Lamp lease on the west.

Active mining work was started immediately on the lease held, several shafts being sunk and levels driven. The Amana shaft reached a depth of 145 feet, and the Warrigal shaft 243 feet. These shafts were connected by a level or cross-cut from the bottom of the Amana shaft, and another level 50 feet below was driven from the Warrigal shaft. These shafts after penetrating the Tertiary basalt, below which a bed of auriferous drift was proved, appear to have reached both slate and augite andesite, but no serpentine.

No "joint" similar to that found in the other mines appears to have been located, and although hopes were entertained that the Tertiary drift would pay to treat, results never justified the anticipation, and the mine was abandoned about the year 1895.

The D'Arcy Estates Gold Mining Company.

This Company was formed during 1894-5, with a nominal capital of £75,000, of which £50,000 was available for developmental work.

An area of land was held under mining title lying on the north side of the Wentworth Company, Frederick's Valley Creek forming the boundary between the two companies.

A main shaft was started about 650 feet north of the creek, with the object of cutting the footwall contact on the underlay. According to information received the hanging wall of the serpentine was reached at 162 feet, and the footwall at a depth of 900 feet. Here the first ore body was proved in the south-east drive, 32 feet from the shaft.

This did not prove very extensive, and as far as available evidence shows, no further makes of ore of any importance were located, although levels were extended along the joint at every 100 feet lift down to the bottom of the shaft. There is considerable difference of opinion as to the actual depth reached in this shaft, but 1,600 or 1,800 feet appears to be the limit, with the weight of evidence in favour of the former.

From the bottom of the shaft, a level was driven 700 feet north-west, and reached the black slate still to be seen on the dump heap. This is interesting as confirmatory proof that the serpentine dies out in a north-westerly direction (see page 35).

In appearance these slates have many points in common with the proved Ordovician slates found elsewhere in the State, and this, together with Mr. Card's remarks on the apparent great age of some of the igneous rocks, points to the possibility of the whole of the Palæozoic rocks in this neighbourhood being referable to the Ordovician period.

Although extensive prospecting work appears to have been carried out underground by this Company, results were disappointing, and the mine eventually closed down with no return to the shareholders.

The Wentworth Extension Gold Mining Company.

The ground held by the Company adjoined the Amana and Aladdin's Lamp Companies' leases on the north.

No information was available with regard to the Company, but apparently it was never a gold producer. A main shaft was sunk near the northern

Digitized by Google

boundary of the Aladdin's Lamp Company. Judging by the dump heap a fair depth was reached (over 600 feet), but the rock penetrated was all augite andesite.

Further information with regard to mining at Lucknow, taken from the Mining Warden's reports as published in the Annual Reports of the Department of Mines, is as follows :—

Orange Division.

"1894.—Owing to the splendid returns from the Lucknow mines, this is now one of the largest gold-producing centres in New South Wales, the output being, for the year, 36,208 oz., valued at £128,197, and giving employment to nearly 700 men. Of that number, the Wentworth Proprietary Company employ 232 men, and raised during the year 10,947 tons, yielding 19,992 oz., valued at £72,118. This company's shaft is now down 828 feet, and their plant is valued at £50,000. The Aladdin's Lamp Gold Mining Company raised 4,298 tons of stone for 14,008 oz. of gold, valued at £47,645. The shaft is down 517 feet, and the company has plant on the ground to the value of £15,000. The Amana Company also raised a quantity of stone during the year, and the D'Arcy Estate Gold Mining Company are busily sinking a main shaft, which is now down about 240 feet.

"1895.—This division now ranks as the largest gold-producing centre in New South Wales, the value of the gold won during the past year aggregating £292,229, as compared with £128,197 in 1894. The Wentworth Proprietary Company, at Lucknow, is responsible for the large increase in the returns, as it put through 9,381 tons of stone for a yield of 58,100 oz., valued at £203,350. This company employs over 300 men, and has erected plant on its property to the value of £50,000. Good stone is now being raised from the 800 feet level. The Aladdin's Lamp Gold Mining Company has also extended its operations during the year, and put through 3,889 tons for 23,078 oz., valued at £80,773. This company employs 100 men, and is working at the 700 feet level. The Amana Company did very little work during the year, and has now ceased work. Derrett and party have put in a tunnel for a distance of 200 feet on Carroll's private land, and have very promising indications of obtaining payable gold. The D'Arcy Estate Gold Mining Company is still pushing forward prospecting operations, and employs twenty-five men on the work.

"1896.—This year's returns from the Orange Division are disappointing, the figures being 29,446 oz., as compared with 83,342 oz. in 1895. The decrease is traceable to the mines at Lucknow.

"The Wentworth Proprietary Company are still in full work, employing about 400 men, and during the year they have been carrying out extensive prospecting work. They put through 9,368 tons, which yielded 12,048 oz., a decrease of 46,052 oz. on their previous year's output; the Aladdin's Lamp Company, 3,052 tons, for 16,718 oz., a reduction of 6,360 oz. on 1895. From these two mines alone the aggregate quantity of gold won was less by 52,412 oz. than the previous year, which nearly accounts for the decrease of 64,094 oz. in our total yield for the year as compared with 1895. The D'Arcy Estate Company are now down 900 feet, with good prospects at that level. The Wentworth Extension (Limited) are sinking for the lode, and have reached a depth of 480 feet. A large area of land has been taken up on the supposed line of lode adjoining this company's property. On the Bletchington estate the syndicate have their shaft down 180 feet on a similar formation to the Lucknow Mine, but not yet payable. Prospecting work is being

Digitized by Google

pushed forward on Kerr and Gilmour's private land west of Lucknow, where occurs a formation similar to that so successfully worked at Lucknow.

"1897.—In reviewing the year's operations in the Orange Division we find a big falling off in the output from the Lucknow mines, which has seriously affected the returns from this division, which in 1895 ranked as the largest gold-producer in the Colony. For the sake of comparison the figures for the last three years are given :—

	oz.
1895	83,342
1896	29,446
1897	12,524

"Although the Lucknow mines are responsible for this falling off, it must not be imagined that these mines are any the less valuable, as during the past year the strike, which lasted for several months, had the effect of seriously hampering the operations of the companies. The fact that very extensive prospecting operations have been carried on show that in the near future it may reasonably be expected that some handsome returns will be the result. The Wentworth Proprietary Company, Lucknow, are now on good stone, and have their main shaft down 900 feet. The stone raised was 6,225 tons, which yielded 5,281 oz. of gold. In the same locality the Aladdin Company have two shafts down 600 and 700 feet respectively. Their output for the year was 6,064 oz. from 3,027 tons of stone. This company have also a good show of ore ahead. The D'Arcy Estate Gold Mining Company (Limited), also at Lucknow, have the deepest shaft on this field, having reached 920 feet; some ore has been raised and sent to England for treatment, but the returns are not yet to hand. The Wentworth Extension (Limited) are still sinking for the lode, and have now reached 628 feet. It is gratifying to know that full work is now proceeding in these mines, and that the sad effects of the strike are disappearing, the men left out of employment having drifted into other localities and started prospecting on their own account.

"1898.—It is pleasing to be able to report that the gold returns from this Division have largely increased as compared with the previous year. For the sake of comparison, the returns for the past four years are given :—

	oz.
1895	83,342
1896	29,446
1897	12,524
1898	27,536

"The principal mine in this Division is at Lucknow, which is owned by the Wentworth Gold-fields Proprietary Company (Limited); the next in importance being that owned by the Aladdin's Lamp Gold Mining Company, also at Lucknow.

"The former mine raised and treated 10,870 tons for 17,600 oz., and the latter 4,866 tons for 7,344 oz., during the past year. Particulars of the operations of these mines for the past three years may prove interesting.

Details.	Wentworth Mine.			Aladdin's Lamp Mine.		
	1896.	1897.	1898.	1896.	1897.	1898.
Men employed	385	400	291	120	150	67
Tons raised	2,368	6,225	10,870	3,052	3,027	4,866
Yield in ounces	12,048	5,281	17,600	16,718	6,064	7,344
Value	£42,564	£18,752	£61,600	£58,195	£20,710	£22,032

Digitized by Google

"The increased tonnage with decreased labour during the past year is most striking.

"Mr. Lock, the general manager of these mines, has kindly furnished some further particulars regarding them, and as these mines have yielded, during the past year, some £83,000 worth of gold, it will be interesting to know something of their peculiarities. The increase in the results this year prove that the ore bodies are increasing at the greater depth. In reference to the difference as shown in the increase of ore raised by less men in 1898 to that raised in 1897, is accounted for by the fact that a large quantity of dead work was done in 1897, which has led to the increase of the returns for 1898. Further prospects in the larger mine are still excellent. The Homeward Bound Company and the Hon. A. T. Kerr are likely in the future to prove the direction of this rich joint. At present it is merely a subject of speculation, as Mr. Kerr has a similar joint, but it runs at right angles to the Lucknow joint. Mr. Lock says :—

"'All the workings along the outcrop of the 'joint' are on the property of the Wentworth Gold-field Proprietary Company (Limited), and its subsidiary the Aladdin's Lamp Gold Mining Company (Limited), and it is to them more particularly that my remarks will apply.

"'Difficulties in the way of studying the salient features of the field are interposed by a flow of basalt (probably post-tertiary, and derived from the neighbouring—distant about 7 miles north-west—volcanic cones known as the Canoblas), which has covered the surface over a very wide area; and had it not been for local erosion of recent age, notably where a little water-course called Parker's Creek crosses the line or 'joint' just south of the Greek's shaft, the buried mineral wealth would have been hard to discover. It was from this tiny creek-bed that the first alluvial gold was panned in the early sixties. .

"'Concerning the 'joint' already several times alluded to, the dotted line on the sketch, following almost a north-westerly and south-easterly course, and connecting various shafts, indicates a zone of contact between two classess of rock which form the 'country' beneath the basalt. This 'contact' line has frequently been called 'the Lucknow lode'—a highly convenient misnomer, which has been abundantly utilised by promoters of mining schemes for many miles around in utter disregard of obvious geological facts. Admitted that this 'contact' line or 'joint' is of primary significance in relation to the auriferous deposits, it is certainly neither a 'lode' nor, as Mr. Wilkinson opined, is it a 'fissure.' It would seem to be simply a line of metamorphic action. To the south-west of this line the 'country' is an igneous rock, called 'diorite' by the local miners, 'augite-andesite' by Mr. Pittman, the Government Geologist, 'pyroxene-andesite' by Herr Schmeisser, and in part 'hornblendic felsite' by Mr. Wilkinson. There appears to be no true diorite present, but the changes in the rock mass are so frequent and numerous that it is next to impossible to give it any final and exclusive name. To the north-east of the dividing line the rock is serpentine, but while in many places the demarcation between the two is most pronounced, in many others it is a matter of the very greatest difficulty to determine where the one begins and the other ends, and long stretches of rock are encountered possessing none of the essential features of either. Though the general 'strike' of this 'joint' is about north-west and south-east, there are sundry turns and breaks in its longitudinal course, the greatest yet encountered being about 400 feet. Regarded transversely, the 'dip' of the 'joint' varies from the

Digitized by Google

vertical to the horizontal, and the mean angle is somewhere about 60 degreese Farther to the north-east again 'diorite' reasserts itself, to be in its turn once more followed by serpentine. These other 'joints' have a more westerly course than the main one, and effect a junction with it at several hundred feet to the north-west of the Jackass shaft. The main 'joint' from which so much gold has been and is still being won, has been worked on uninterruptedly for a length of 4,000 feet, and there are many indications that its full extent, whether to the north-west or to the south-east, has not yet been determined. Moreover, considerable work—in all some 1,257 feet of sinking and driving—has been done by the Hon. A. T. Kerr on his Wellwood estate, at a distance of about a mile north-west from the nearest Lucknow level, disclosing a 'joint' precisely similar, only that it runs north-east and south-west, or at right-angles to the true Lucknow 'joint.' The discovery of other 'joints' is triumphantly proclaimed now and again by the prospectors who are hunting for them outside of the boundaries of the Wentworth estate; but it has been repeatedly proved that other conditions besides a 'joint,' however well marked it may be, are also required to make it a gold mine even of the most moderate dimensions. This fact is brought home very forcibly by the knowledge that out of a total of 28,000 feet, or about 5 miles of drives on the 'joint' in the Wentworth and Aladdin mines, only about 1,400 feet carry any ore at all; so that there are 20 feet of absolutely barren 'joint' for every 1 foot that is productive—a truly phenomenal state of things.

"'Without trespassing too much on the domain of the geologist, it may be permissible to hazard a conjecture that the primary source of the gold in the Lucknow mines is to be sought in the quartz veins that occur in the vicinity of the 'joint'; certainly no reef gold has ever been found at any great distance from one or the other of them. These veins live in the 'diorite,' but invariably cease abruptly where they encounter the 'joint,' the silicious matter (quartz) being there almost wholly replaced by coarsely crystalline calcite (carbonate of lime), carrying more or less free gold, auriferous mispickel, all the common sulphides (generally non-auriferous), and in many instances metallic antimony and stibnite. The quartz veins themselves, however, away from the joint, though auriferous are not payably so, and the enrichments occur only where calcite predominates and at or near the point of contact with this joint. The payable formation consists, therefore, not of a 'lode' or 'reef,' nor indeed of any reasonably continuous body of stone, but of an erratic series of 'pipes' or shoots representing the fag ends of quartz veins, which abut against the joint, for the most part at an angle of about 55 degrees, as shown on the sketch plan. Sometimes, it is true, the ore body will extend for a limited distance along the joint, but in no case does it cross and enter the serpentine, though in an instance or two small bunches of ore have been found on the serpentine side of the joint. What the exact agency was which effected this change in the quartz reefs cannot positively be stated, but that a leaching and re-disposition have taken place seems obvious. Moreover, appearances would indicate that the serpentine is an alteration-product of the 'diorite,' seeing that every gradation from the one to the other can be found, and in the serpentine are encountered disconnected masses of rock having an unchanged 'diorite' core and a truly serpentinous exterior, showing that for some reason the metamorphic action ceased before its work was completed. Apparently the thermo-chemical waters which accompanied and followed the disturbance which created the original rift

Digitized by Google

in the 'diorite' mass, changing it within a certain zone into serpentine, were also the leaching agents. Mr. C. S. Wilkinson gave it as his opinion that 'the vein fissures have chiefly derived their metalliferous contents by infiltration from the serpentine formation'; but the knowledge to be gained from the very limited workings of his day may easily have misled even so skilled an observer.

"'As if the uncertainties of mining in such a formation were not sufficient, each pipe or shoot is also extremely capricious in size and in productiveness. Sometimes for a depth of a 100 feet and more a pipe will practically disappear, nothing but the tiniest line of calcite indicating the course it has followed, and there is absolutely no reliable guide by which to forecast the future. Frequently the ore-body is split up and parted by masses of secondary minerals, such as dolomite and other vein matter quite barren of gold but inseparable in breaking down the ore. On the other hand, the ore itself is phenomenally rich, the clean mispickel assaying as high as 1,500 oz. of fine gold to the ton; and out of the hundreds of tons of hand-picked ore shipped to London none has ever contained much less than 50 oz., while many parcels have averaged over 500 oz. to the ton. This is the redeeming feature which makes it possible to work the mines profitably. A peculiarity of the mispickel found here, distinguishing it from the product of every other known mine so far as observation has gone, is the striking arrangement of the crystals, forming star-like masses varying in diameter from half an inch upwards, locally known as 'Prince of Wales' feathers.' A less noticeable but never absent peculiarity is the occurrence of antimony in alloy with the gold. Thus both the ore and the gold from this mine can be identified with certainty—a very useful factor in detecting thefts.

"'In the mine workings the most notable features are the hardness and good standing qualities of the ground, except the serpentine, which is very heavy in places; and the coolness, dryness, and airiness of even the longest ends and deepest winzes. The equipment of the mine may be classed as superlatively good, probably superior to anything else in Australasia; and the total absence of even small accidents where 500 to 600 men are constantly employed speaks for itself. Compressed-air drills are much used, and these help to perfect the ventilation. Nothing but Nobel's best explosives are admitted, and in all sinking work firing is done by battery. Electric lighting is adopted at every platt in each shaft, and wherever a winch, fan, or pump is installed. A unique system of electric signalling (the message being repeated both from and to the engine-room, and recorded at each level, rendering mistakes and accidents well nigh impossible) replaces the old-fashioned knocker and line, which remain, however, as a stand-by in case of injury to the electric cable. Telephonic communication is carried right through the mine, and into the office, and the mine manager's bedroom. Safety-catches are everywhere, and the Phœnix underlie shaft is furnished with a special cage for conveying men up and down, affording sitting room for a dozen at a time. The diamond drill is much used for prospecting; but with ore-bodies of such limited extent and uncertain course it does not prove very satisfactory. Lockers are securely built in the mine for receiving the rich ore as fast as it is shot down, and there special members of the staff supervise the operations of picking and bagging it ready for transmission to the surface, each bag being separately numbered, weighed, and checked at every stage.

Digitized by Google

"'As underground, so on the surface, no detail is neglected for securing economy, speed, and ease in handling. The grade of the tramways and the construction of the huge ore-bins, with doors so contrived that a boy can easily manage the filling of a truck, though over 100 tons of ore be lying in the bin, all show the care and forethought of the trained engineer. The rock-breakers are driven by a special engine of most suitable type, and reduce the ore to about 1½-inch cubes for the battery—an ingenious water-sprinkler being under control of the breakers attendant to minimise the dust created. The broken ore is elevated in trucks to the top of the battery, and tipped into bins of large capacity. Automatic roller-feeders are used. One man per shift (eight hours) easily manages the thirty-five stamps. These latter weigh about 800 lb., and drop 7 inches at the rate of ninety-eight blows a minute. Angle-slotted Russia iron screens (No. 7 needle) have displaced all other kinds tried. The Blanton self-tightening cam is being gradually introduced as the old (keyed) pattern wears out. Packed iron glands, invented by Mr. Robert Canning, the chief engineer, are being substituted with marked advantage for wooden guide-blocks. Belt-driving, with the aid of tightners and Smith's patent pulley covering, is in favour. After prolonged trials of cast-iron, cast-steel, forged-steel, chrome-steel (both English and German), and manganese-steel for shoes and dies, by far the most satisfactory results have been obtained from shoes of Hadfield's (Sheffield, England) chrome or manganese cast-steel, working in dies of forged-steel imported from Glasgow. So hard is the gangue accompanying the milling dirt that the stamp duty per head per twenty-four hours ranges only between 1½ and 1¾ ton. Mercury and small amalgamated copper splash-plates are used in the boxes, and large copper plate tables and apron plates (no ripples or wells) outside. About 12½ per cent. of the total amalgam caught is collected in the mortar boxes. Owing to the carbonate of lime in the ore, no trouble arising from oxidising sulphides is encountered; nor is it found that the antimony and arsenic carried by the ore have any prejudicial effect on amalgamation. The pulp on leaving the outside plates passes through mercury traps, and thence goes to the frue-vanners (two 4-foot belts to each five stamps), where the pyrites is collected for subsequent drying (by waste steam) and shipment to London. The concentrates average about 3 per cent. by weight (dry) of the ore milled, and frequently contain as much as 20 oz. fine gold per ton. The tailings—elevated by a gigantic bucket-wheel to gain height for crossing a public road—flow away to a heap, whence they will soon be taken to pass through treatment by cyanide, containing as they do for the most part some 5 dwt. of gold bullion per ton. In their passage they flow through an apparatus which automatically takes a sample of the whole stream every half-hour. The average value of the milling-dirt is about 1¼ oz. per ton, and the ratio of extraction, by battery and vanner, is in round figures 85 per cent.

"'The establishment of the Proprietary and Aladdin Companies embraces four sets of winding-gear, four air-compressors, fourteen boilers, three dynamos for electric lighting, with foundry and fitting-shops replete with every appliance for effecting repairs and renewals. Its resources may be judged when it is said that its ordinary work includes casting battery boxes weighing over 3 tons, welding steel rods 3 inches thick, and reboring the cylinders of engines and pumps."

Digitized by Google

"In addition to the work described in the Proprietary and Aladdin Mines, the D'Arcy Estates have done a lot of work during the year, namely, 101 feet of sinking, and 2,053 feet of drives, cross-cuts, &c., making a total of work done 6,031 feet, the deepest level being 1,021 feet. The capital of the company having been expended, the labour conditions are suspended for six months to enable the company to reconstruct. Fifty-nine men have been employed. About £4,000 worth of machinery is in use, and a trial crushing of 25 tons has only been brought to the surface.

"The Wentworth Extension Mines Company has sunk its shaft to a total depth of 760 feet, and the drives in it reach a distance of a few feet; but it is the intention of this company to sink deeper, and for this purpose the labour has been concentrated to the main shaft. Twenty-six men are employed.

"The Homeward Bound Syndicate, which are about to work 100 acres to the north of the Aladdin Mine, are about to commence work at once, having prospected the land and decided upon a site for a main shaft.

"The Hon. A. T. Kerr has been prospecting on his property, and has sunk seven shafts from 30 to 202 feet deep, in all 503 feet, and driven 1,257 feet. He has a winch and 10-h.p. boiler and hauling appliances for water and stone. £2,426 has been well expended on this property.

"1899.—At the Wentworth Proprietary Mine, Lucknow, the works have been under partial suspension for some time, as, owing to the lack of payable ore, the company have been unable to raise fresh capital to carry on the extensive prospecting which is the characteristic of this mine, the payable ore being only found in bunches or shoots. An experienced geologist and mining expert has come from England to thoroughly examine the mine. This is probably the outcome of Mr. Lock's visit to the Home Country.

"From 130 to 300 men have been employed at the above mine during the year, and 1,800 feet of new work, consisting of winzes, rises, drives, and cuts, and diamond drill bores, has been done, of which 756 feet was done by contract. £12,872 worth of gold has been won, but not all from newly mined ore. The company erected a slimes cyanide plant, which, unfortuuately, has not proved a success, owing to the fact that the slimes take more than sixty hours to settle after agitation with cyanide solution. Experiments are still being made, and a parcel of slimes is awaiting treatment in Melbourne by a machine invented by Messrs. Draper and Riley, who claim that they can extract clean solution and leave the residues practically dry. If this machine can do what they state it will, the work of treating the slimes will be at once resumed; if not, the solution will have to be extracted with filter presses. The extraction of gold from the few tons treated was 90 per cent. There is an immense quantity of tailings, some 50,000 tons, and it was hoped that the proceeds from these would have provided the capital which it is now found necessary to raise otherwise. The year's work in this mine produced 3,306·5 oz. of gold, valued at £12,872. This is a very large decrease on the output for 1898, but early in the present year (1900) a rich find was reported at the 500 feet level—as good as ever—which proves that the mine is far from worked out. To get at the new find will, however, entail a great deal of dead work.

Digitized by Google

"At the Aladdin's Lamp Mine, adjoining the foregoing mine, 846 feet of similar work has been done during the year, 272 feet of which was done under contract. The number of men employed during the year was from 29 to 74. The bullion obtained was 5,702·8 oz., the value being £22,210. This mine is worked in conjunction with the Wentworth Proprietary.

"The Wentworth Company are carrying on a mine near Stuart Town, of which, although out of this district, a short account is here given as exemplifying their persistency and enterprise. Since reopening up the mine in June last, a new main shaft, 16 ft. by 3 ft. 6 in., has been sunk 160 feet from the surface level. Here a cross-cut, 6 ft. 6 in. by 4 ft., has been driven 81 feet, and a shaft, 9 ft. by 3 ft. 6 in., sunk a further distance of 77 feet, making a total in all of 237 feet. The shaft is close timbered to a depth of 125 feet. A poppet-head of Oregon timber, 40 feet high, has been erected. A ten-stamp battery, with rock breaker, &c., is in course of erection, whilst winding engine, boilers, and air compressing plant are all laid down. A dam has been constructed by means of puddle and clay embankment 235 feet long, 15 feet high in centre, with a base and top of 75 feet and 25 feet respectively, capable of conserving 6,000,000 gallons of water. One mile of close panel fencing has been erected round the claim. Nearly all the necessary fittings and castings have been turned out of the fitting shops at Lucknow.

"The Wentworth Extension at Lucknow is still vigorously prospecting on one lease, two others being allowed suspension.

"At the D'Arcy Estate Mine at Lucknow, little or no work has been done during the year; but arrangements are in course of negotiation for its management to be taken up by Mr. Newman, M.L.A., when work will begin again at once.

"The Homebound, north of the Aladdin is being sunk on with English capital.

"The Wallaroi lease is also being worked.

"These are all in the Lucknow supposed line of contact of the basalt and serpentine. Should payable gold be struck in any of these mines, no doubt a large amount of labour would be absorbed, and good results be obtained.'

The plates reproduced in this work were published in the Annual Report for this year.

Subsequent to the year 1899 mining gradually languished at Lucknow, until in 1904 the only miners engaged on the field were a few parties of prospectors, who recovered £1,093 worth of gold during the year.

In 1903 the Australian Gold Recovery Company started to cyanide the tailings dumps, 5,800 tons being treated, and in 1904 they treated 35,000 tons. No returns of the gold recovered are available, but, based on Mr. Lock's estimate, some £48,000 worth should have been recoverable.

During 1905 and 1906 this company were still treating the tailings dumps, but no returns are available as to yields, £60,000, however, appears to be a conservative estimate of the total value of gold recovered from the tailings up to 1907, when the company ceased work.

In the Annual Report for 1907 we learn that the Golden Contact Mine recovered £6,197 worth of gold, but no information was obtained regarding this company.

In 1908 a new make of ore was found in the old workings, and £6,40 worth of gold was recovered from 691 tons.

Digitized by Google

Work was resumed on the tailings dumps by a small syndicate during the year, and 2,951 tons yielded £1,753 worth of gold. This syndicate continued to treat tailings up to the end of 1913 with the following results :—

	Tons of tailings treated.	Value of gold recovered.
		£
1908	2,951	6,401
1909	2,200	1,168
1910	2,200	1,960
1911	3,750	1,859
1912	4,200 loads	1,795
1913	3,200 „	1,190
		£14,373

In addition to the above, a small private cyanide plant (Mr. Murphy's) appears to have treated 1,200 tons of tailings in 1911 for a recovery of £666 worth of gold. Altogether something in the neighbourhood of £63,000 seems to have been won from the tailings dumps, and even then it is recognised that a considerable quantity was washed down the creek during floods.

In 1912 the Golden Contact Company went into liquidation, subsequent efforts to refloat any of the properties at Lucknow failed, and in 1913 all the workings were flooded.

In 1914 the gold leases then held by the D'Arcy Wentworth Company were cancelled for non-fulfilment of labour conditions, and portion of them again pegged out by speculators.

Practically no mining has been done on this field since 1912, but a small syndicate recently completed the erection of a ten-head stamper battery for the purpose of treating the dump heaps. During the writer's visit to the field in February, 1920, a small trial crushing was put through with very satisfactory results, but it yet remains to be proved that there is any large quantity of material in the dumps which will pay to treat.

Owing to the lapse of time since gold was first won at Lucknow, and the incomplete nature of the gold returns over the greater part of the time during which mining was carried on there, it is not possible to give exact figures as to the actual gold yields.

An estimate made from all available published figures, with only a comparatively small allowance for returns not published, is well over £2,000,000 worth, recovered from an area of less than 50 acres.

This is probably a World's record, more particularly as the bulk of the gold was obtained above the 750 feet level, and only a restricted area of the ground opened up paid to stope out.

PREVIOUS REFERENCE.

When it is realised the amount of gold that was recovered, and the interesting nature of the ore bodies at Lucknow, it is surprising that the literature upon that gold-field is so meagre.

As far as the writer is aware, the only important references published with regard to the Lucknow gold-field, are those given below. This as apart from mine Manager's or Superintendents' reports furnished to the English Companies, brief mention of mining conditions given in the Annual Reports of the Department of Mines, contemporaneous newspaper articles, and brief reference to mineral occurrences.*

* Minerals of New South Wales, &c., by A. Liversidge, M.A., F.R.S., Sydney, 1888.

Digitized by Google

1881.—Report upon the Wentworth Gold-field, by Mr. C. S. Wilkinson, Geological Surveyor in Charge, Ann. Rep., Dept. for Mines, New South Wales, 1881, pp. 134–6.

1888.—" Extracts and Reports on the Lucknow or Wentworth Gold-field," by H. W. Newman, May, 1888, published at office of *Western Advocate*, Orange.

1898.—" The Gold-fields of Australia," by Schmeisser and Vogelsang, translated by H. Louis, M.A., &c., London, 1898, p. 121, &c.

1899.—" The Lucknow (N.S.W.) Gold-field " by A. R. Canning, Assoc. Inst. M. and M., Trans. Inst. Mining and Metallurgy, London, 1899, vii., pp. 238–263.

1899.—Discussion on above by C. J. Alford, *Ibid.*, pp. 264–270.

1900.—" The Auriferous Deposits of Lucknow," by E. F. Pittman, A.R.S.M., Government Geologist, Records Geol. Survey, N.S.W., vii, October, 1900, pp. 1–9.

1901.—" Mineral Resources of New South Wales," by E. F. Pittman, A.R.S.M., Government Geologist, Sydney, 1901, pp. 43–50.

Digitized by Google

CHAPTER II.

GEOLOGY.

The geology of the Wentworth Gold-field is somewhat restricted as regards variety of formations. This is due mainly to the limited area of Palæozoic rocks exposed within the belt of country dealt with in the present work.

A geological reconnaissance of a much larger surrounding area failed to disclose any important factors bearing upon the occurrence of gold at Lucknow, and consequently no detailed description is included here.

Apart from the Tertiary drift and recent alluvium, no sedimentary rocks were found outcropping, but in at least two cases highly fissile slates were penetrated in underground workings, as evidenced by the dump heaps at the Amana and D'Arcy shafts.

The geological formations observed *in situ*, placed in descending chronological order, are as follows :—

1. Tertiary (Upper Pliocene). Newer or plateau basalts of Sussmilch.* Lava flows and beds of volcanic tuff.
2. Tertiary (Miocene.) Auriferous river gravels.
3. Palæozoic. Limburgite-Serpentine.
4. Palæozoic. Intrusive augite andesite, diorite, and other rock types

1. *Tertiary lava flows.*—

These occupy by far the largest area of country round Lucknow, and extend north from there for over eight miles, seven miles to the east, four miles to the west, and over sixteen miles to the south.

No detailed geological or petrological study of these rocks was made, as they have no immediate bearing upon the subject of this paper.

Field evidence points to at least three distinct flows, separated in places by beds of volcanic tuff, the individual rock types comprising basalts, andesites, and a dense vitreous lava exhibiting pronounced pseudo bedding. The latter is to be seen on the main Bathurst-road about a quarter of a mile east of Lucknow, and the other types surround the village.

In the neighbourhood of P.G.L. 12, parish of Anson, and extending in a north-westerly direction into Portion 4, Parish of Orange, a massive bed of volcanic agglomerate is to be seen. This consists of rounded and angular fragments of lava, for the most part vesicular, cemented in a volcanic base.

The belt does not lie horizontally, but is gradually rising to the north-west, and in portion 4, Parish of Orange, it is about 100 feet above the outcrop in P.G.L. 12, along a distance of about one-third of a mile. The origin of this horizon is possibly capable of more than one solution, but evidence points to the belief that it represents the basal portion of a flow poured over a pre-existing lava, which had undergone slight disintegration.

Near the Amana shaft, and in a cutting on the Orange-road just before reaching Lucknow, exposures of tuffs were observed.

Most of these lavas exhibit steam vesicles up to 1½ inch in length, the longer axis and thick ends pointing more or less in a south-west or westerly direction. The vent or vents from which these flows emanated were in all probability situated in the neighbourhood of the Canoblas Mountains, lying about 6 miles west of Lucknow, which are known to have been a centre of volcanic activity during Tertiary times.

* "Geology of New South Wales," by C. A. Sussmilch, F.G.S., Sydney, 1914, p. 200.

Digitized by Google

The maximum remaining thickness of these flows within the area embraced by the present work appears to be in the neighbourhood of 150 feet, as proved by shafts or boreholes. These lavas have had no association with the gold deposition at Lucknow, and in addition to having covered the auriferous Tertiary leads, thus preventing to a large extent the enrichment of recent stream gravels by a process of natural sluicing, they mask the greater part of the older Palæozoic rocks, thus rendering the work of the prospector both difficult and costly.

2. *Tertiary auriferous river gravels.*—

These accumulations of cemented sand and gravel occur immediately beneath the lava flows. They range in thickness from 2 to 4 feet, but the actual width of the river bed and flood plain could not be determined owing to the limited extent and detached nature of the available outcrops.

Outcrops are not easy to find at the present day, for they have been largely obscured by accumulations of surface soil or old mining dumps. The approximate positions of the outcrops are, however, indicated on the accompanying geological map.

Old shafts sunk through the basalt along the crest of Chapel Hill indicate the course of one of these leads, but that there were confluent streams was proved in the Amana shaft, where a bed of auriferous drift was penetrated at a depth of 150 feet and driven on for some distance. The auriferous nature of these Tertiary deep leads appears to have been realised as far back as 1865, when the lead under Chapel Hill was worked for an average return of 19 dwt. to the ton (Mr. H. W. Newman's papers). Work was carried on intermittently for some years, but no sensational finds appear to have been made. Much of the gravel has been compacted into a fairly hard conglomerate, and crushing had to be resorted to to set free the gold.

In 1893 the Wentworth Proprietary Company commenced to drive a tunnel under Chapel Hill in search of virgin areas of the alluvial ground, but work had to be suspended in 1894 owing to wet seasons having caused an excessive accumulation of water.

In 1898 the Company again took up this work, and the following extract from the Annual Report of the Company's Superintendent (Mr. C. G. Warnford Lock) furnishes some interesting information on the question of the economic possibilities of the Tertiary leads.

"In the third quarter of the year, work was commenced reopening the adit, which was put in several years ago to connect with the old alluvial workings under Chapel Hill. The mouth of this adit lies almost immediately behind the rock-breaker building, between it and the battery. Our object in undertaking this work was twofold, and each appears to justify the small expense incurred. The first was to prospect for certain low-grade 'wash,' or broken down or scattered reef that had not been found payable to remove in the old days (more than twenty-five years ago), when milling charges alone were 12s. 6d. per ton, and other expenses correspondingly high. Secondly, to drive for new country lying to the south-east, of the worked-out alluvial ground. Here it seems that a channel, and possibly the main one, has been missed, and only the south-west branch of the stream followed. Old plans point very clearly to this conclusion, and if such should prove to be the case, a valuable property exists unworked. In detail, the work has been as follows:—The first 140 feet were found open and in good order, but from there on to the present face the work has been almost equivalent

Digitized by Google

to re-driving. In places, large quantities of fallen rock and decomposed ground required removal, after which close timbering was necessary; at others, long open sets have been sufficient; whilst latterly, the drive being through new country, the whole face has had to be broken down with pick and run out. The roof of the drive is excellent, being formed of solid basalt; under this, the 'wash' resting on a 'diorite' bottom. This last is very decomposed, of a very clayey nature, and hardly recognisable as diorite. Such gravel as has been left standing was found to range from a trace up to 16 dwt. per ton, several assays being got of 5 to 7 dwt.; but as the drive has been keeping along the side of the old stream, little can be learned until cross-cuts into the channel are put in. As such work would seriously hinder advance, it cannot yet be undertaken. The better stone only exists in pillars, and therefore represents but little value; it is, however, indicative of what was previously broken down, and it is intended presently to take out and crush a small parcel of this to see what duty the stamps will return when working on similar gravel. This crushing would also show whether the small percentage of clay that does exist would be detrimental to gold extraction by means of battery only. Some of the wash has been found 2½ feet thick. Large angular quartz fragments are found distributed through the wash, proving beyond any doubt that these gravel deposits are shed from reefs at no great distance, and the coarseness of the gold found bears out the theory. One highly satisfactory feature is the entire absence of drift, or fine worthless sand, overlying the gravel proper which renders work both expensive (owing to the amount of timber required) and dangreous. With basalt immediately overlying the wash, the cost of breaking it and getting it to the battery should not exceed 2s. 6d. per ton. Four shafts, sunk through the basalt, extend one beyond the other in a south-westerly direction for a distance of 2,200 feet. Soon after passing the first of these, near which the ground has been very extensively stopped, a direct line was taken for the new ground that we are anxious to reach. The second shaft is now near at hand, and it is intended to reopen this, and get away with our waste rock by this means, instead of running it out along the great length of drive now lying behind us. The cost of this work, so far, has been very small, less than £200 for the 955 feet. This figure covers the value (£50) of the timber used, which can all be drawn and used in the mine proper if this prospecting work should prove futile."

In the Superintendent's Annual Report for 1900 we learn that the tunnel under the basalt was in 1,300 feet. On reaching the old Result shaft, it was found that a much larger area of ground had been worked out by the early miners than was anticipated, and that a new shaft through the basalt would be necessary if work were to be continued. In view of the information available, however, operations were discontinued.

From the foregoing it will be seen that the Tertiary deep lead has received considerable attention from the miner in the vicinity of Lucknow. It was assumed by Mr. C. S. Wilkinson* that this lead extended in the direction of the Forest Gold-field, some 8 miles to the south-west, where wonderful returns were obtained from a deep lead. There is, therefore, ample scope for prospecting along the assumed course of the lead, but the whole of the land surface consists of Tertiary lava flows, and it is impossible from surface indications to determine the course of the deep lead, thus greatly increasing the difficulty of locating desirable bore sites.

* Ann. Rept, Dept. of Mines, 1881—p. 131.

Digitized by Google

The lead may be accidentally located in well sinking, in which case further prospecting by means of the diamond drill would be justified owing to the probability of a payable auriferous lead existing.

PALÆOZOIC ROCKS.

Serpentine and Limburgite.—

The origin of serpentine has always been a controversial subject, and there is considerable divergence expressed by various authorities. It is not the province of the present work to enter into the discussion, nor was there any opportunity to study the underground association of the serpentine at Lucknow, whilst the surface exposures are now largely obscured by mullock dumps. Professor W. N. Benson, B.A., D.Sc., in a valuable work on the origin of serpentine* gives exhaustive references and makes comments upon this question.

In order that the reader of the present report may follow the theory advanced as to the origin of the Lucknow serpentine, a few extracts from Professor Benson's work are given. It is pointed out that "A study of the modern literature showed a general agreement that such serpentine masses were originally peridotites, and have been hydrated by deep-seated process" (page 693).

Also on page 698: "The commencement of the last decade of the nineteenth century saw firmly established the recognition of the derivation of serpentine from intrusive peridotite."

Again, in his summary (page 727) he states: "The various lines of inquiry we have endeavoured to follow support the general view in regard to the large ultrabasic masses that the chrysotite or antigorite-serpentine of which they are composed is an alteration product of an originally intrusive peridotite, often more or less pyroxenic, and that in some cases at least the hydration was brought about by the agency of waters emanating from the same magma that produced the peridotite, though not generally until a considerable amount of further differentiation has taken place."

Mr. E. F. Pittman, A.R.S.M., for many years Government Geologist of New South Wales†, held the view that the Lucknow serpentine was derived from the decomposition of the augite andesite, and pointed out that a microscopic examination of numerous rock specimens made by Professor T. W. E. David, B.A., F.R.S. (1901) "fully bears out this assumption."

On the other hand, Schmeisser and Vogelsang,‡ after an examination of the Lucknow field and a study of numerous rock sections under the microscope, express the view that: "From the mineral composition of the serpentine it would appear highly improbable that it could have had a common origin with the pyroxene-andesite rock that forms the footwall."

Again, Mr. C. J. Alford submitted a short paper on the Lucknow rocks§ in connection with the discussion on Mr. A. R. Canning's paper on that gold-field‖, in which he points out that the specimens of the "diorite" examined by him proved "to be a magma basalt or limburgite composed of augite magnetite and pyrites in a volcanic glass."

---

* American Journal of Science, XLVI, No. 276, Dec. 1918. pp. 693–731.
† "Mineral Resources of New South Wales," by E. F. Pittman, A.R.S.M., Govt. Geologist, Sydney, 1901, p. 46.
‡ "The Gold-fields of Australia," translated by H. Louis, M.A., &c., London, 1898, p. 123.
§ Trans. Inst. Mining and Metallurgy, London, Vol. VII, 1899, p. 265.
‖ *Ibid*, pp. 238 to 263.

Digitized by Google

Mr. G. W. Card, A.R.S.M., Curator and Mineralogist to the Geological Survey, also identified a specimen obtained as a " kernel " in the serpentine as limburgite. Although Professor Benson makes no reference to a limburgite passing into a serpentine, both limburgite and peridotite consist of ultra basic rocks practically devoid of felspar, and there appears to be no reason why the former should not become serpentinised as well as the latter. In the light of all the available evidence, the present writer holds the opinion that the Lucknow belt of serpentine represents a mass of altered limburgite which intruded the augite andesite during earth movements. The central plug, or downward connection of the mass is probably situated to the eastward of the old mine workings, and the limburgite appears to have forced its way into the andesite along a fault plane or planes caused by the intrusion of the central plug, and extending longitudinally from it. The limburgite, in addition to widening the fault fissures, possibly caught up, or partially absorbed masses of the intruded andesite. This resulted in a boat-shaped mass of limburgite with included belts of andesite, connected by a core to a deep-seated magma basin.

In places the serpentine has a brecciated appearance, possibly caused by a slight shattering of portions of the original rock type. In cooling this rock mass shrank, and the contact joint or original fault fissures again opened, thus facilitating the circulation of magmatic waters, and the serpentinisation of the limburgite would be brought about, with an accompanying or possibly later deposition of lode material in the joints or fissures.

Unfortunately the Writer was not able to collect suitable rock specimens *in situ* underground, and surface exposures on the field are all more or less unsatisfactory and limited. Specimens collected from the dump heaps have largely lost their scientific value, for their relationship to surrounding rocks cannot be determined, but several specimens bearing on the question of the origin of the serpentine were examined by Mr. G. W. Card, who had microscope sections prepared. His examinations of these slides, and others previously prepared, afforded the following information :—

" Among the rocks collected at Lucknow, I recognised undoubted augite andesite and others that may well belong to the same class, but are altered (not serpentinised) out of recognition. They are probably of very great antiquity. Among the earlier specimens there is an andesite, but I recognise a true diorite, and would classify an old specimen collected by Mr. E. F. Pittman, and marked as ' Kernel,' as limburgite."

According to the foregoing there would appear to be at least three rock types present in the Palæozoic series apart from the serpentine, namely, augite andesite, diorite, and limburgite, but the Writer is not in a position to express an opinion as to their relationship to one another *in situ*.

It is recognised that under present conditions at Lucknow one cannot hope to throw much light on this interesting question, even if it were desirable to enlarge upon it at the expense of the main object of this publication. Whatever the origin, there is practically no room for doubt that the serpentinisation was closely associated with the formation of the ore bodies.

OTHER OUTCROPS OF SERPENTINE IN THE NEIGHBOURHOOD.

About three-quarters of a mile east of the village of Lucknow, within P.M.L. 12, a small inlier of serpentine is seen. This exposure is surrounded with Tertiary lava, and its association with the Palæozoic rocks cannot be

Digitized by Google

seen. The outcrop probably represents portion of the eastward extension of the main Lucknow serpentine mass, and appears to be in the neighbourhood of the hanging-wall side of it.

A shallow underlay shaft (50 feet deep) has been sunk here, but no contact reached. The Prospecting Board recently granted Government assistance to cross-cut from the bottom of this shaft in the direction of the supposed contact, and if reached, to drive along it in search of auriferous makes of stone. In the writer's opinion the locality is worthy of attention from the miner, but it must be remembered that no extensive payably auriferous makes were found on this wall within the area previously mined. This may be explained by the limited amount of prospecting done along the hanging-wall contact, but, on the other hand, there is the possibility that conditions along this contact were not favourable for gold deposition. The latter possibility is not favoured by the limited evidence available, which points to many similar conditions, and until it has had a fair trial one must recognise its potentialities as a gold producer.

On the opposite side of the Bathurst-road from the above, and right alongside the road, a shaft was sunk some years ago through the Tertiary lavas into the underlying serpentine. Judging by the dump heap, no augite andesite was penetrated in the workings, therefore it would appear that the contact joint was not present. About one and a half miles south-west of this shaft, within portion 94, parish of Huntley, a shaft has been sunk to a depth of about 150 feet through basalt, into augite andesite, therefore there must be a contact somewhere between these points, and the writer is of the opinion that it is not very far south of the shaft near the Bathurst-road. The questions are:—Does the "fissure" or "joint" (fault plane) extend this far, and were conditions favourable for gold precipitation? These points can only be settled by systematic prospecting, and are apparently well worthy of attention from mining men.

WESTERLY EXTENSION OF THE LUCKNOW SERPENTINE BELT.

Owing to the Tertiary lava flows occupying the whole of the land surface for over two miles west of Lucknow, the limits of the serpentine occurrence in that direction cannot be determined on surface evidence.

The longitudinal section accompanying this work shows sedimentary rocks underlying the basalt at the western end, but it should be pointed out that the only evidence in support of this is the presence of slate on the Amana shaft dump heaps, and also in the dumps of the D'Arcy shaft. In support of the assumed termination of the serpentine in that direction, it may be pointed out that Mr. G. C. Warnford Lock, in his Annual Report to the Directors for the year ending 23rd September, 1899, states that the 500 feet level north-west "is 20 feet into the Amana ground, and although the level follows a true joint" no serpentine was seen for a great distance from the face. Continuing north-west, however, about 2 miles beyond the Amana ground, along the Orange-road, small outcrops of serpentine are to be seen as follows:—On the Orange-road passing through Portion 6; a few chains south, within that portion; in Portion 21, and in Portion 7, just off the Orange-Icely road, all in the Parish of Orange.

Whereas the trend of the Lucknow belt is approximately North 60 West the outcrops above referred to occur along a bearing of about North 20 West. In the Writer's opinion these represent isolated intrusions, probably only

Digitized by Google

connected with the Lucknow belt at a great depth, in a common magma basin.

Other belts of serpentine examined lie about eight miles north-east of Lucknow, in Portion 9, Parish of Byng, and in Portion 2, Parish of Freemantle, both in the County of Bathurst. In each case these occurrences are seen to be intruding sedimentary rocks (slates and limestones), and no andesite occurs near them, a point worthy of consideration in connection with the origin of the Lucknow serpentine.

OLDER PALÆOZOIC INTRUSION.

Exposures of igneous rocks are to be seen on either side, at the western end, and associated with the serpentine belt at Lucknow. The nature of their occurrence cannot be determined on account of the absence of any exposures of associated sedimentary rocks. It has been suggseted that the augite andesite may be an intrusion subsequent to that of the serpentine, and there are factors such as the inclusion of pipes and belts of the former rock in the serpentine which do suggest this.

On the other hand, we find that the quartz reefs in the augite andesite are all cut off by the serpentine as though faulted, and this appears to the Writer to point to an intrusion into the andesite, with accompanying faulting.

In the absence of any concrete evidence, a definite expression of opinion is not advisable, but the Writer inclines to the belief that the augite andesite is an intrusion older than the serpentine. The older intrusive rocks have been classified by different writers under various names, such as "hornblendic felsite, passing in places into diorite" (C. S. Wilkinson), "pyroxene-andesite" (Schmeisser and Vogelsang), and "augite-andesite" (E. F. Pittman), whilst the name "diorite" was used by local miners.

It seems probable that modern petrologists would prefer the term augite andesite for the bulk of this rock exposure, but in places considerable metamorphism renders identification impossible, and it may be that more than one type of rock is present. (See page 34.)

Whilst recognising the foregoing, the name augite andesite will be adhered to in this work, for a recent examination of a microscopic section of the typical rock made by Mr. G. W. Card, A.R.S.M., Petrologist to the Geological Survey, resulted in the determination given on page 31.

In a shallow cutting on the Orange-road, about a quarter of a mile before reaching Lucknow, a decomposed rock is seen, the identity of which is doubtful. It may either belong to the older Palæozoic series, or to the Tertiary lavas.

In the banks of Frederick's Valley Creek, about three-quarters of a mile below Lucknow, a highly crushed belt of rocks is exposed. The rock appears to resemble a crushed augite andesite, and possibly represents a belt of that rock which was subject to crushing, faulting, and alteration during the intrusion of the serpentine.

The interpretation adopted regarding the isolated belts and pipes of augite andesite (see section with map) is that they represent portions of that rock mass isolated by the fault fissures into which the serpentine was intruded.

The augite andesite does not appear to have much primary significance in the genesis of the rich gold deposits of Lucknow, for although traversed by numerous quartz veins, none of these were very rich in gold contents, and practically all of them did not pay to work away from the actual serpentine contact.

Digitized by Google

CHAPTER III.

MODE OF OCCURRENCE OF ORE BODIES, ORIGIN AND FUTURE POSSIBILITIES, WITH SUGGESTIONS AS TO PROSPECTING.

Owing to circumstances already referred to, the Writer is not in a position to describe the nature and mode of occurrence of the Lucknow ore bodies from a personal study of them.

Mr. E. F. Pittman, A.R.S.M., has dealt with this subject, however,* and the following is a summary of his investigations :—

"When the hanging-wall of the main fissure, at its junction with an east and west vein, is not composed of serpentine, there is an absence of ore; and whenever calcite is found in the fissure, with andesite forming both walls, no ore occurs in it. In the unoxidised zone, therefore, auriferous deposits are only found in this remarkable mine under the following conditions, viz. :—

1. At or near the junction of an east and west vein with the main fissure.
2. When serpentine forms the hanging wall of the main fissure; and
3. When the gangue consists of calcite.

Again, the ore-bodies occur in four ways, viz. :—

1. As chutes or pipes along the junction of the quartz veins with the main fissure, with a length of from 40 to 50 feet;
2. As bunches extending horizontally along the main fissure, but always starting from the toe of a quartz vein;
3. As 'droppers' from the footwall of the main fissure;
4. As chutes in the east and west veins (near their junction with the main fissure), where calcite replaces the quartz for some distance."

Mr. Pittman's article throws light upon questions now incapable of investigation.

With regard to the origin of these ore bodies the following theories and suggestions are formulated :—

It would appear that a number of quartz reefs existed in the augite andesite prior to the intrusion of the serpentine-producing rock. These were not markedly auriferous, and it never paid to work the original reefs any distance away from the zone most affected by that intrusion.

Practically all authorities who have dealt with the Lucknow field agree that the footwall joint represents a fault plane, and the present examination is in agreement with that hypothesis.

If the assumption that the serpentine rock mass intruded the andesite from a central pipe or fissure be correct, it is easy to understand how the earth movements which led to its injection into the overlying strata, would cause considerable faulting, and it is apparently along one of these that the "main joint" of Lucknow occurs. What were known as "false joints" appear to have led to considerable unproductive prospecting work on the field, as they contained no ore bodies, but were difficult to detect from the main joint. They appear to have consisted of slight fractures filled with dig, running more or less parallel with the main joint, and were probably caused by sympathetic movement at the time of the heavy faulting.

* "Mineral Resources of New South Wales"—Edward F. Pittman, Sydney, 1901. pp. 44–48.

Digitized by Google

The parent rock of the serpentine then appears to have been forced into a highly strained and fractured zone, widening the original fissures, and possibly assimilating portion of the intruded rocks. Then a cooling and contracting period was followed by the injection of magmatic solutions and vapours which brought about serpentinisation, and formed the ore bodies.

A point strongly in favour of the idea that the ore bodies were formed during, or associated with, serpentinisation is the fact that both Lock and Canning state definitely* that although quartz reefs were proved to come in contact with the joint in the augite andesite in the north-westerly workings, *where the serpentine had ceased to be present*, gold values were always negligible. As a general rule the ore bodies are contained within a footwall of augite andesite and a hanging-wall of serpentine, but an exception to this was proved in workings on the Homeward Bound vein. According to Mr. A. R. Canning† this make of ore passed upwards from the lower or vertical portion of the contact joint into the serpentine for some 20 or 30 feet, with a base 18 feet wide, and cutting out in an apex. At a period subsequent to the formation of the ore bodies, further slight faulting took place in a north and south direction‡, and this may have resulted in further enrichment of the mineralised portion of the ore bodies, by facilitating the passage of circulating solutions or vapours.

The occurrence of ore bodies only near the junction of the "spur" quartz reefs with the main joint is probably more than a coincidence, for such is the hard and fast rule apparently, and previous references afford no evidence of exceptions. This might be due in the first place to the fault movement having affected the rock mass more pronouncedly in the neighbourhood of the quartz "ribs," thus causing more open spaces. Subsequently the permeating solutions and vapours may have thus found more favourable precipitating conditions in the neighbourhood of the pre-existing quartz reefs, and hence the formation of ore bodies in such positions.

So much for the footwall "joint," and the question now arises: What conditions did mining operations disclose along the hanging-wall contact?

No reference has been made by previous writers to the presence of a "joint" on this (the northern) side of the serpentine, but Mr. A. R. Canning, in his paper§, points out that: "So far as is known, the second body of diorite" (*i.e.*, the hanging-wall mass. L.F.H.) "does not carry gold-bearing reefs."

The general hypothesis as to the mode of occurrence of the serpentine belt herein advanced presupposes somewhat similar conditions, but not necessarily the presence of intersected quartz reefs.

Mine plans indicate that this boundary of the serpentine was exposed in several cross-cuts, and it must surely have been penetrated by the D'Arcy shaft, but apparently in no case was it driven along in search of ore bodies or intersected reefs. If such is in reality the case, then the writer holds the opinion that its possibilities as a source of gold have never received a fair trial. An opportunity to test this is now lost within the area previously worked, on account of the enormous body of water in the old workings, but such can be done elsewhere, as set out on page 35. Under the conditions

* Annual Reports to Wentworth Company by Mr. Lock—Trans. Inst. Mining and Metallurgy, London, 1899, VII, p. 224, &c.
† Trans. Inst. Mining and Metallurgy, VII, 1899, p. 243.
‡ *Ibid*, p. 244.
§ *Ibid*, p. 240.

Digitized by Google

in which the data for this work were obtained, it is not considered advisable to indulge freely in speculation, but it is considered that the possibilities of this area again becoming a gold producer are sufficiently favourable to justify the opinions expressed, although often unsupported by concrete evidence.

In the early days, the Lucknow gold occurrences did not call for the expenditure of much capital, and the individual miner could take up a small claim with a reasonable prospect of obtaining good returns. The gold deposits in many places reached the grass roots, and practically no dead work was necessary until water level was reached, and new "spurs" had to be located.

At the present day there is no longer an unworked area of the older gold-bearing strata available to the miner for prospecting, and it is necessary to sink first through the capping of Tertiary lava flows. Consequently there is not much inducement to the miner, as he sees nothing to guide him in choosing a site for prospecting. By a careful investigation of geological conditions, however, it is possible to indicate within certain limits, the areas most likely to justify attention, and thus possibly avoid considerably useless dead work.

The possibilities existing may be set out as follows :—

(*a*) *Auriferous deep lead.*—There are no surface indications which would enable the geologist to trace the courses of any of the Tertiary leads under the basalt, therefore location and prospecting by systematic methods, *i.e.*, shafts or bores, is likely to prove a costly undertaking.

(*b*) *Auriferous lode formations.*—Within limits, the geologist is here in a position to afford information which should assist the prospector, although the rock exposures are very limited upon which to base deductions.

There appears to be sufficient evidence to indicate that prospecting along the extended strike of the main "joint" of Lucknow in a north-westerly direction is not likely to yield favourable results.

There is conclusive evidence available that the serpentine did not extend in that direction even as far as the Amana shaft. Other exposures of that rock nearer Orange do not appear to belong to the same rock mass, and have so far afforded no indications that payable auriferous deposits will be found in their neighbourhood. Hence further prospecting in that direction does not seem warranted.

The hanging-wall contact between the augite andesite and the serpentine has been exposed in several places in mine workings, but apparently was never prospected to any extent. No payable gold deposits were located along this contact on the surface, but the length of exposure is short, and largely covered with alluvial deposits or detrital material. This contact, in the writer's opinion, is worthy of further prospecting, for there is evidence that quartz spurs are present in the andesite. An opportunity of testing it from the old mine-workings is no longer possible without incurring prohibitive costs, but some half a mile easterly from the old workings, on P.G.L. 12, Parish of Anson, a small outcrop of serpentine occurs which is probably in the neighbourhood of the hanging-wall contact. Here an opportunity presents itself of cross-cutting to the contact, and investigating its nature at

Digitized by Google

a minimum cost. If conditions look promising, such as a pronounced "joint," it should be well worth while driving along it in search of conditions similar to those found along the main footwall joint.

As already stated, aid was granted from the Prospecting Vote early in 1920 to assist in this work, and the information to be gained should prove most useful, and possibly of great economic importance.

Within the belt of country lying immediately to the south-east of the old Lucknow mines, geological evidence is available which indicates clearly that at least one of the necessary factors associated with the Lucknow ore bodies must occur there.

Some years ago a shaft was sunk to a depth of 150 feet through basalt into the underlying older rocks within Portion 94, Parish of Huntley. The dump from this shaft shows clearly that much of the work done was in augite andesite, similar to the rock forming the footwall of the Lucknow ore bodies.

Within Portion 61, Parish of Huntley, in the south-east corner of the portion, and adjacent to the Bathurst-road, a shaft was sunk some time ago to a depth of 80 feet through basalt into serpentine. From the bottom of this shaft drives were extended 150 feet due west, then 200 feet in a north-easterly direction, and again back to the shaft, but no values were proved. Judging by the dump, augite andesite was not reached, but the prospectors followed a so-called joint in the north-easterly drive.

In the light of the above it is self evident that a contact between the two rocks must occur somewhere between these two shafts. Other shafts in the neighbourhood only appear to have been sunk into the basalt, so that the proved limit within which the contact may be expected to lie is over a mile wide.

If the general strike of the Lucknow contact be extended in a south-easterly direction, it would pass between the Bathurst and Spring Hill roads within Portion 61, Parish of Huntley. The older rocks are here covered with Tertiary lava, varying in thickness from about 50 to 100 feet. For this reason it is impossible from surface indications either to exactly locate the position of the contact, or to ascertain whether other necessary conditions for the occurrence of ore are present, such as a "joint" along a fault plane, quartz spurs striking the joint, and favourable factors for gold precipitation.

The writer considers that this area is well worthy of attention from the miner, for it is within a quarter of a mile of the Shamrock shaft workings, from which a high gold recovery was obtained in the past. Work appears to have been abandoned here not because the "joint" ceased, but because limited prospecting failed to disclose further spur veins, and there are no surface indications as a guide in picking up the next vein.

Past efforts to investigate conditions at this end of the field appear to have been carried out in the absence of any concrete knowledge of geological conditions, and for this reason failed to secure definite evidence regarding the nature of the prospecting work required.

In order to prospect thoroughly this area it is considered the following work is necessary :—

A shaft should be sunk through the basalt, and for about 20 feet into the underlying Palæozoic rocks at a point about midway between the Bathurst and Spring Hill roads. This may necessitate 100 feet of sinking, and subsequent work will depend upon the nature of the bed rock. If it is serpentine, a cross-cut south will be necessary to intersect the footwall contact. If,

Digitized by Google

on the other hand, augite andesite occurs in the bottom of the shaft, a cross-cut north will be necessary to reach the contact. On reaching that zone it should be possible for a geologist to express a tentative opinion as to whether a fissure exists.

As the quartz spurs which came up to the contact, and were associated with the ore deposits at Lucknow were in places some hundreds of feet apart, it may be necessary after proving the presence of a "joint" to drive along it in search of a reef coming into contact with it. This could be done with advantage in both directions, in order not to miss anything handy to the shaft. The difficulty to the layman will be the identification of the various rock types, and for this reason the advice of a competent geologist should be obtained from time to time in order to minimise the risk of mistakes.

On the whole, the Writer is very favourably impressed with the latent possibilities of the areas specified in this portion of the paper, and strongly advises prospecting on the lines set out.

[4 plates and 2 folded maps.]

Sydney: William Applegate Gullick, Government Printer.—1920.

† 36751—C

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, B.A., Government Geologist.

MINERAL RESOURCES.

No. 31.

NOTES

ON

PETROLEUM AND NATURAL GAS,

AND THE

POSSIBILITIES OF THEIR OCCURRENCE IN NEW SOUTH WALES.

BY

LEO J. JONES, A.S.T.C.,

Geological Surveyor.

Issued under the direction of the Honorable George Cann, M.L.A.
Minister for Mines.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1921.

† 25979—A

[1s. 6d.]

Digitized by Google

Science Library
TN
122
.N421
A3
no.31

Digitized by Google

New South Wales Geol. Surv. Science Library
12-10-1923

TABLE OF CONTENTS.

PAGES.

INTRODUCTION—National Importance of Petroleum, Its Many Uses, Present Supplies, Imports, Rewards Offered to Encourage Prospecting, Absence of Oil-bearing Strata, Lack of Literature, Erroneous Ideas, Nature of Inquiries, Object of Report ... 5-6

CHAPTER I.—Petroleum and Allied Hydrocarbons, Petroleum—Its Composition and Physical Characters, Natural Gas, Dry and Wet Varieties, Ozokerite, Asphaltum or Mineral Pitch, Asphalt Rock, Native Bitumens 7-8

CHAPTER II.—Origin of Petroleum and Natural Gas, Inorganic and Organic Theories of Origin, Process of Oil Formation 9-10

CHAPTER III.—Occurrence of Petroleum, Nature of Deposits, Reservoir Beds, Migration of Oil and Gas, Suitable Geological Structures, Summary of Necessary Conditions for Occurrence of Oil and Gas, Age of Deposits 11-16

CHAPTER IV.—Prospecting for Oil, Nature of Sediments to be looked for, Surface Indications of Petroleum, Supposed Indications of Petroleum 17-20

CHAPTER V.—Drilling for Petroleum, Methods of Drilling, Water in Wells 21-22

CHAPTER VI.—Review of Oil Prospecting Operations in New South Wales, Nature of Prospecting Work done— 23-39

(1) Ravine, Lobb's Hole. (2) Redbank, near Richmond. (3) Penrith. (4) Grafton. (5) Coombell, Richmond River District. (6) Near Scone. (7) Other Localities

CHAPTER VII.—Possibilities of Obtaining Petroleum in New South Wales, Geological Sequence of Sedimentary Formation in New South Wales 40-46

APPENDIX I.—Mining Regulations regarding the Prospecting for Oil in New South Wales 47

APPENDIX II.—Federal and State Notifications of Rewards Offered for the Discovery of Petroleum 47-48

Digitized by Google

Digitized by Google

INTRODUCTION.

PETROLEUM and its products are now essential for so many industrial purposes that the question of possessing adequate supplies is one of national importance.

As a fuel crude oil has a calorific value at least one and a half times greater than the best of our Greta coals, but it is only the poorer-grade oils, with a high-flash point, that are used direct as fuel. The great importance of petroleum is due to the lighter volatile oils—petroleum spirit, gasoline, benzine, naphtha—the illuminating oils—chiefly kerosene—and the lubricating oils, that are obtained by its distillation.

The light distillates obtained from some varieties of petroleum evaporate on exposure to the air and are largely used as anæsthetics, solvents, cleaning solutions, and in types of carburetted-air plants. The somewhat heavier spirits, including gasoline, benzine, &c., are required in ever increasing quantities for internal-combustion engines of all kinds. The illuminating oils are required for purposes of heating, cooking, and illumination. An intermediate distillate between illuminating and lubricating oils, known as solar oil, is used for enriching poor quality coal-gas. Lubricating oils are in great demand for all classes of machinery.

Vaseline and other products are required in pharmacy; paraffin in the manufacture of candles, insulating materials, chewing gum, &c. The residue from asphaltic oils is largely used in road construction as a binder and surfacing material, also in the manufacture of waterproofing materials, &c.

Commercial deposits of petroleum have not yet been discovered in Australia, and consequently New South Wales is dependent upon oversea sources for its supplies. The following table shows the quantity and value of the imports of petroleum and its products into New South Wales for the past five years :—

Year.	Petroleum spirit, including Benzine, Benzoline, Gasoline, Petrol, Pentane, and Naphtha.		Kerosene and other refined Petroleum burning Oils.		Mineral Lubricating Oils.		Residual.	
	Quantity. Gallons.	Value. £	Quantity. Gallons.	Value. £	Quantity. Gallons.	Value. £	Quantity. Gallons.	Value. £
1919–20	8,125,571	748,270	5,111,573	256,094	1,564,062	167,605	4,926,032	79,555
1918–19	8,177,280	673,733	5,110,598	212,273	3,884,891	403,901	3,401,558	52,112
1917–18	6,805,920	522,485	5,033,947	160,683	2,772,229	236,935	1,146,023	6,128
1916–17	6,743,093	502,212	6,050,952	166,569	2,683,720	158,955	4,796,371	23,016
1915–16	6,870,432	368,790	8,112,145	196,680	2,785,117	150,481	2,509,378	32,168

The great bulk of the imported oils are obtained from America and the Dutch East Indies.

The demand for petroleum for commercial requirements in New South Wales is continually increasing, and the problem of locating deposits within our own territory becomes more insistent.

Though petroleum is very widespread in its occurrence throughout the world, there is unfortunately but little evidence at present—fragments of asphaltum drifted from unknown sources, found along the southern coastline;

Digitized by Google

a little heavy viscous oil in a bore at Richmond; and "wet" gas in the bore at Roma, Queensland—to indicate even the presence of oil-bearing strata throughout Australia.

In order to encourage prospecting for oil, the Federal Government has offered a reward of £50,000 for the discovery of commercial deposits within Australia. In addition, the New South Wales Government have offered a further reward of £10,000 for the discovery and production of 100,000 gallons of natural mineral oil within the confines of the State. The State Government, moreover, is prepared to help prospectors with the advice of its technical officers, and to subsidise operations carried out at an approved site.

Numerous inquiries regarding the nature of oil deposits, the possibilities of its occurrence in certain districts, and the best methods of prospecting are continually being answered by the Mines Department. Requests are frequently being received for the services of a geologist to inspect reported surface indications of the occurrence of oil, and when the case appears to warrant it an officer is sent to inspect and advise.

In every case to date, however, the reports on a supposed oil discovery prove, on investigation, to be of little or no value. A scum of oxide of iron on water is commonly mistaken for the iridescent colours assumed by thin layers of floating oil. Gas emanations are generally the marsh gas given off by carbonaceous (coaly) matter at a depth, or decaying vegetation in stagnant pools at the surface. The supposed "bitumen" or asphaltum generally proves to be animal matter or thin streaks of anthracitic coal.

The lack of surface indications of the presence of petroleum, and the absence of easily accessible literature dealing with oil, is probably responsible for this subject being but little understood by the general public in Australia, and many erroneous ideas are prevalent.

The popular belief that petroleum is a very capricious and uncertain mineral, and that the only way to be sure of finding it is to drill a deep bore-hole, is a fallacy. The occurrence of petroleum, like any other mineral, is governed by laws under which it is formed and concentrated in reservoirs beneath the earth's surface. The oil is not stored in large subterranean caverns, but is contained in solid but porous rocks, of which sandstone, lime-stone, and shale are types.

All rocks do not carry petroleum. In fact it only occurs in commercial quantities in sedimentary rocks formed under definite conditions, possessing abundant organic remains, and having the requisite geological structures for storing the oil when formed.

Excellent text-books dealing with petroleum and the petroleum industry generally are extant, among which might be mentioned—

V. Ziegler ...	...	... "Popular Oil Geology."
A. Beeby Thompson		... "Oilfield Development."
Boverton Redwood		... "Petroleum and its Products."
Cunningham Craig		... "Oil Finding."

But these are not easily accessible to the general public, and the following notes, which include several extracts from the above works, have been prepared in the hope that they will be of some value and assistance to those interested in the discovery of crude oil within New South Wales.

Digitized by Google

CHAPTER I.

PETROLEUM AND ALLIED HYDROCARBONS.

Petroleum.

Petroleum, or mineral oil, is a liquid belonging to the group of natural hydrocarbons (bitumen), which include gases, oils, and solids composed essentially of complex mixtures of compounds of carbon and hydrogen. Such oils consist of a mixture of hydrocarbon compounds of the paraffin (C_nH_{2n+2}) series, and of the olefine and naphthene (C_nH_{2n}) series, with small quantities of sulphur, nitrogen, and oxygen usually present as impurities. When oils have an excess of the C_nH_{2n+2} series they are known as paraffin-base oils, while those carrying a preponderance of the C_nH_{2n} series are known as asphalt-base oils. Occasionally oils are found which carry equal proportions of both series, and these are known as mixed-base oils.

The colour and fluidity of petroleum are variable, depending mainly on composition. The paraffin-base oils are yellow to brown by transmitted light, green by reflected light, and ordinarily quite fluid. Asphalt-base oils are generally opaque, ranging from dark brown to deep black by reflected light, and are viscous.

The specific gravity or weight, as compared with an equal volume of water, ranges from 0·711 to 0·945, the paraffin oil being the lightest and the asphalt varieties the heaviest.

The temperature at which crude petroleum solidifies ranges from 82° F. to several degrees below zero. The flashing point, or the lowest temperature at which inflammable vapours are given off, may be as low as zero to as high as 37° F.; but these are extreme limits. There is also a great range in the boiling point, which varies from 180° F. to 338° F.

The odour of crude oils is characteristic, but variable; while some varieties have a pleasant aromatic odour others have the disagreeable smell of hydrogen-sulphide.

The various liquid hydrocarbons comprising crude petroleum vary in their gravity and temperature of volatilization. The more important oils can be separated from crude petroleum by distillation. The crude oil is heated in retorts at various temperatures, and the volatile material driven off and condensed. The very volatile matter is given off at low temperatures, the less volatile at increasingly higher temperature, and the following products are obtained:—First, the volatile oils, including petroleum spirits, gasoline, benzine, and naphtha; second, the illuminating oils, or kerosene; third, the lubricating oils; fourth, fuel oils; and, last, paraffin, if present in sufficient quantities.

The paraffin-base oils are more valuable on account of the higher quality and quantity of naphthas, illuminating oils, and lubricating oils which they produce. Those with an asphalt base are of inferior quality, and chiefly valuable for fuel.

Digitized by Google

Allied Hydrocarbons.

1. *Natural Gas.*—Every oilfield carries gas, but there are many gas-fields in which oil does not occur in commercial quantities. This may be accounted for when it is remembered that, although both oil and gas may have been derived from a common source, the tendency of the gas is to accumulate in the highest portions of the strata, and the greater ease with which it escapes through imperfections of the covering layers enables it to extend beyond the reach of the oil with which it was originally associated.

Ziegler* classifies gas occurring in nature as: "First, Mineral gas; second, Swamp gas; and third, Natural gas.

Mineral gases, he points out, are of inorganic origin, and include gases given off during volcanic eruptions and from geysers—they are of no commercial value.

"Swamp gas is formed by the decay of vegetable matter under water," and is present in most marshes, swamps, and old wells. Its composition is essentially menthane (CH_4) or marsh gas.

Under the term Natural gas, Ziegler, includes all commercially valuable gases occurring in nature. Two varieties of natural gas occur, viz., "dry" gas and "wet" gas.

Dry gas is essentially menthane (CH_4), and is generally derived from decomposing coal-beds; very rarely from oil-pools.

Wet gas usually contains from 80 to 90 per cent. of menthane (CH_4) and small amounts of ethane (C_2H_6) ethylene (C_2H_4), and hydrogen H). Carbon-dioxide (CO_2), nitrogen (N), and oxygen (O) are generally present. Wet gas is nearly always associated with oil-pools. Some of the heavier hydrocarbons, such as gasoline, are generally present in quantities of a few pints per thousand cubic feet, and frequently drip from this gas.

2. *Ozokerite.*—A natural paraffin-wax, with a specific gravity varying from 0·85 to 0·95. It has been formed by the oxidation and decomposition of the hydrocarbons of the paraffin-base petroleums.

3. *Asphaltum or Mineral Pitch.*—Is a viscous, pasty, black-coloured hydrocarbon, solid at ordinary temperatures. It has resulted from the combined action of evaporation and atmospheric oxidation upon liquid asphalt-base petroleums as they issue from outcropping strata.

4. *Asphalt Rock or Bituminous Rock* is the name applied to arenaceous, calcareous or argillaceous strata impregnated to a varying degree with bituminous or asphaltic matter—the residue left by the evaporation of the lighter products of petroleum. Such rocks are frequently the outcrops of oil-bearing strata.

5. *Native Bitumens*, which include Gilsonite, Grahamite, Albertite, &c., are brilliant black-coloured, solid, and brittle hydrocarbons. They have resulted from the evaporation—free from atmospheric oxidation—of petroleum during its passage underground.

---

* Popular Oil Geology, p. 15.

Digitized by Google

CHAPTER II.

ORIGIN OF PETROLEUM AND NATURAL GAS.

The question of the origin of petroleum and natural gas is a much disputed one. The several theories advanced may be grouped into two classes—(*a*) Inorganic and (*b*) Organic.

(*a*) *Inorganic theories.*—These attribute the origin of petroleum to chemical reactions within the interior of the earth, involving the formation of gaseous hydrocarbons, which rise in fissures from considerable depths and condense in the porous rocks of the cooler crustal rocks. In one case it is supposed that the interior of the earth contains free alkaline metals, and upon these carbon dioxide reacts to form acetylides which, when acted upon by water vapour, yield hydrocarbons.

Another theory presupposes the existence of iron carbides within the earth to which water gaining access would generate hydrocarbons. A further theory endeavours to show that petroleum may originate from the action of volcanic gases upon limestone.

Such theories, based upon purely hypothetical considerations, have not found general acceptance.

(*b*) *Organic Theories.*—That petroleum has been derived from the dead remains of organisms is now generally accepted, but there is still a good deal of controversy as to the forms of life concerned, and whether vegetable or animal matter, or both, have been the main contributing source.

1. *Animal origin.*—The supporters of this theory contend that petroleum and natural gas are formed by the decomposition or destructive distillation of animal matter that become enclosed and buried beneath air-tight sediments before the total decomposition of the fatty parts had taken place.

It is pointed out that oil and gas are found in strata containing abundant animal but little or no plant remains, particularly so in the cases of the Canadian, Appalachian, Egyptian, Mexican, and Persian oil-fields, where the oil appears to be indigenous to the limestone in which it is found, and of the Californian, Russian and Caucasian oil-fields, where the oil, derived from neighbouring highly fossiliferous shales, is contained in sandstones.

In the Kuban district, Russia, A. Beeby Thompson* records that—

> "Petroleum impregnations are confined to strata containing abundant fish remains, and where the fossils are absent the sediments are not petroliferous. The oil sources of Peru are confined to a series of strata remarkably rich in fossil beds."

Oils similar to petroleum have been extracted from animal fats in the laboratory.

* A. Beeby Thompson—Oil Field Development, p. 230.

Digitized by Google

2. *Plant origin.*—The similarity of the gases given off by coal in certain mines to the gas in oil-fields and the fact that coals and lignites on destructive distillation yield hydrocarbons of the paraffin and olefine series similar to those of petroleum, led to the early belief that petroleum was derived from coals and lignites. Crude oil has been recorded as oozing out of coal beds at Scotland, at Vendee in France, and on the Island of Trinidad. The presence of oil in districts far removed from coal-beds has led to a modification of the coal-origin theory, and it is now considered by some authorities that "terrestrial vegetation has in some cases undergone a mineralization, being converted into liquid and gaseous hydrocarbons, instead of the usual solid lignites and coals."

Others suggest that petroleum has been derived from the remains of gelatinous plants, such as algæ, buried under accumulating sediments and protected from decomposition. Subsequently these remains are distilled into the various oils and gases met with in nature.

In the laboratory it is possible to distil oils resembling crude petroleum from such plants.

3. *Animal and plant origin.*—The theory assigning the origin of oil and gas to both animal and plant remains is the one most generally held. It is considered* "that wherever sediments are laid down, enclosing either animal or vegetable matter, there bitumens may be produced. The presence of water, preferably salt, the exclusion of air, and the existence of an impervious protecting stratum of clay seems to be essential conditions towards rendering the transformation possible. Seaweeds, mollusks, crustaceans, fishes, and even microscopic organisms of many kinds may contribute material to the change. In some cases plants may predominate; in others animal remains; and the character of the hydrocarbons produced is likely to vary accordingly, just as petroleum varies in different fields. In one region we find chiefly paraffins, in another napthenes, and in others nitrogenous or sulphuretted oils."

The variations in the composition of petroleum are not only due to the differences in the organic materials from which it has been formed, but also to the physical conditions prevailing at the time of formation and to the subsequent migration and resulting filtration that the oil has undergone.

Process of oil formation.—Ziegler† gives the following summary of the condition of oil formation as determined by geological observation :—

1. That the formation of petroleum is a general process.
2. That the original materials represent both animals and plants.
3. That the process of alteration is one of selective putrefaction and distillation, taking place under the following conditions :—
   - (*a*) At comparatively low temperatures.
   - (*b*) Under comparatively great pressures.
   - (*c*) In the presence of water, usually salty.
   - (*d*) During a great space of time.

* F. W. Clarke—Data of Geochemistry, p. 703, 1911.

† Ziegler—Popular Oil Geology, 1918, p. 32.

Digitized by Google

CHAPTER III.

OCCURRENCE OF PETROLEUM.

Commercial supplies of petroleum are only found in sedimentary rocks, except in very rare instances, where it may occur as a secondary deposit in reservoirs contained in metamorphic or igneous rocks.

An interesting occurrence of oil in metamorphic rocks—crystalline schist, is recorded at Placerita Canyon, California. In a report by R. Anderson* on this occurrence, it is stated that the presence of the oil in the crystalline schist is " probably due to its migration from Tertiary beds, in which it is believed to have originated. The accumulation of an appreciable quantity of petroleum in the rocks of this type is so unusual that a recurrence of the peculiar conditions that give rise to it is hardly to be expected."

The opinion held by geologists is that it would be impossible for oil to remain in rocks during their metamorphism, when it would be undergoing tremendous pressure and be subjected to intense heat.

Occasionally traces of oil are found in intrusive igneous rocks, but on investigation it is generally found that such rocks have intruded carbonaceous strata and the oil they contain is a product of the destructive distillation of coaly or lignitic beds through which they have passed.

Such oil can be distinguished from crude petroleum by the high percentage of unsaturated hydrocarbons that it contains.

All sedimentary rocks, however, do not carry petroleum. Since living matter is considered to be the source from which petroleum has been derived, geological conditions at the time of deposition must have been such that living organisms were abundant, and as the preservation of these remains is limited to certain environmental conditions, there must necessarily be great areas of sedimentary rocks devoid of oil. For example, sediments that were deposited under conditions unfavourable to animal and plant life; others that were not suitable to the preservation of existing organisms; and again, others where the entombed organic residues have been dissipated by the deformational processes that the rocks have undergone.

Schuchert† states that " petroleum cannot accumulate upon dry land in deserts, grassy plains, or forests, for here the oxidizing influences are so active that all the volatile parts must be taken away or completely changed. . . . . All rock formations accumulated directly beneath the atmosphere, as continental deposits, must therefore be devoid of commercial quantities of petroleum. Then, too, all deposits, either of the fresh waters or of the seas, which are periodically subjected to atmospheric weathering during their time of accumulation, are also lacking in oil in paying quantities. Hence we may further conclude that all red or reddish, yellowish or white, rain-pitted or sun-cracked deposits, either of continental, fresh-water, or semi-marine origin, are lacking in petroleum in large amounts."

*Preliminary Report on the Geology and Possible Oil Resources on the south-east of San Joaquin Valley, Cal., U.S. G. S., Bull., 471, pp. 114-115, 1913.

† Petroliferous Provinces. Discussion of E. G. Woodruff's Paper, Trans. Am. Inst. Mining Eng., Chicago Meeting, 1919.

Digitized by Google

The following list by Schuchert* of areas unsuitable for the occurrence of petroliferous rocks in North America is of particular interest, as it is directly applicable to New South Wales:—

I. "The impossible areas for petroliferous rocks."

"(a) The more extensive areas of igneous rocks and especially those of the ancient shields (continental massifs LJJ): exception, the smaller dikes.

(b) All pre-Cambrian strata.

(c) All decidedly folded mountainous tracts older than the Cretaceous: exceptions, doomed and block-faulted mountains.

(d) All regionally metamorphosed strata.

(e) Practically all continental or fresh-water deposits: relic seas, so long as they are partly salty, and saline lakes are excluded from this classification.

(f) Practically all marine formations that are thick and uniform in rock character, and that are devoid of interbedded dark shales, thin-bedded, dark, impure limestones, dark marls, or thin-bedded, limy and fossiliferous sandstone.

(g) Practically all oceanic abyssal deposits; these, however, are but rarely present on the continents."

Marine, estuarine, and certain types of lacustrine deposits not too highly folded, crushed, or metamorphosed, consisting of rapidly alternating beds of sandstone, limestone, and shale, and containing abundant organic remains, are particularly favourable for the occurrence of oil and gas.

It is generally admitted that petroleum was rarely produced where it is now found, but through subsequent migration, under definite laws, it has accumulated in reservoirs of various kinds.

Any rock that is capable of holding oil and gas in commercial quantities is known as a "reservoir." Sandstone, sand, gravel, grit, limestone, and shale are the most common type of reservoir rock.

The holding capacity of such rocks is determined by their porosity, or pore space—*i.e.*, the number and size of openings the rocks contain. Porosity depends upon the size and shape of the individual grains conprising a rock and upon the nature and amount of cementing material present. The average porosity of sandstone is approximately 10 per cent. but frequently is much higher. Incoherent sand has a porosity of about 30 per cent.

Sandstone, gravel, and grit form the reservoirs of the Russian, Roumanian, Galician, and Californian oilfields.

Dolomitic limestones rank next to sands and sandstone in importance as reservoir rocks. Limestone, when pure, is ordinarily fine-grained, and has a low percentage of pore space, but, being easily soluble in circulating waters, channels, caverns, and passageways, may be dissolved out and which may ultimately serve as reservoirs for oil. The conversion of a high calcium limestone into a dolomitic limestone results in a considerable shrinkage of the volume of the rock, and may amount to 12·30 per cent. The openings resulting from such shrinkage may serve as receptacles for oil and gas.

Dolomitic limestones form the reservoir rock of the Appalachian, Texan, Canadian, Mexican, Egyptian, and Persian oil-fields.

* *Op cit.*

Digitized by Google

Shales are, for the most part, impervious, and the oil they contain is usually in fractures, fissures, and joint planes which traverse them.

It is essential that the storage or reservoir-rock be entirely covered by impervious strata, such as clay or fine-grained shale, whose imperviousness and freedom from fracture exert the most important influence on the capability of the reservoir-rock to retain its liquid or gaseous content.

Migration of Oil and Gas.—Petroleum and gas originated in practically horizontal strata when the necessary conditions and constituents were present, and probably existed in a finely disseminated condition intermingled with water. The compacting of the sediments would tend to squeeze the oil, gas and water from the fine-grained rocks into the more porous ones. Rock pressure and capillary pressure also play a part in this primary concentration of the oil and gas. The subsequent movements of the oil and gas through the reservoir rocks and their concentration into commercial pools is a result of the differences in gravity of gas, oil, and water, and to the movement of the water induced by hydraulic pressure, heat, or to earth stresses producing a tilting or folding of the strata. The oil, gas, and water originally intimately mixed become separated, the water into the lower parts of the reservoir rock, the oil higher up and the gas into the very highest portion that it can reach, and where suitable rock structures exist accumulation of commercial quantities result.

The separation of the gas, oil, and water is well illustrated by the rapid diminution and final disappearance of gas and oil, and increase of water obtained in progressive wells sunk on the crest of and down the sides of a narrow productive anticlinal fold.

The gas associated with the oil is frequently under great pressure and may be sufficiently strong to force the oil to the surface when the impervious cover of overlying strata is pierced by a borehole. Reduction of pressure consequent on escape of gas gradually lessens the oil flow until the weight of the latter overcomes the pressure and the well ceases to flow, though subsequent pumping operations are assisted by intermittent gushes, due to local accumulation and sudden escape of gas within the oil.

Suitable Geological Structures.—It is essential that a suitable geological structure be present, one that will allow the oil and gas contained in the reservoir rocks to be concentrated in sufficient quantities to be of commercial importance. It is possible to have a porous bed impregnated with petroleum, and yet have no commercial value, because the quantity present is not sufficient to produce a flow when the beds are pierced by boring.

Any arrangement of the rocks so that they form a trap or barrier to arrest the escape of oil and gas, and thus permit of their accumulation may be classed as a suitable geological structure.

Such structures may occur in great variety of form. The greater number of the oil-fields of the world are in folded regions. The oil and gas pools may occur in all possible structural relationships to the folds; their location is in large part due to the quantity of water present in the reservoir rocks. When these are completely saturated the oil and gas occupy the crests of the folds. When water is absent the oil-pools will occur in the synclinal troughs.

Digitized by Google

The following are among the most important favourable structures:—

Anticline Structure.—Rocks originally laid down flat or horizontal have as a result of earth movements become tilted or inclined, and occasionally are thrown into wave-like folds. The wave-like fold would form an "anticline," and the intervening hollow a syncline. The crest of the anticline serves admirably for the concentration of oil and gas.

Domes.—Structural domes resulting from ordinary folding, laccolitic intrusion of igneous rocks, or to the effect of expansion resulting from the crystallisation of certain minerals (salt) at a depth. The prolific oil-fields of Texas and Louisiana are situated on "dome" structures.

Monoclinal Fold or Structural Terrace.—A change in the amount of dip of strata sufficient to cause a flattening of the rocks produces a structure known as a structural terrace. When the change of dip is sufficient to arrest the movement of oil and gas passing through, then the structure becomes a favourable one.

Lenticular Structure.—Lenticular beds of porous rock sandwiched between impervious layers may, if oil be present in the neighbouring rocks, serve as a reservoir for the accumulation of oil and gas.

Igneous Intrusions.—The intrusion of an igneous rock into petroliferous strata might form a barrier against which the oil and gas would accumulate. Several instances of this occur in the Mexican oil-fields.

Faults.—Oil has in certain cases been concentrated as the result of a fault cutting across a reservoir rock and bringing it up against an impervious bed.

Unconformities.—In rare cases commercial supplies of oil may accumulate at an unconformable junction of two horizons.

Summary of conditions necessary for the occurrence of commercial supplies of oil and gas.

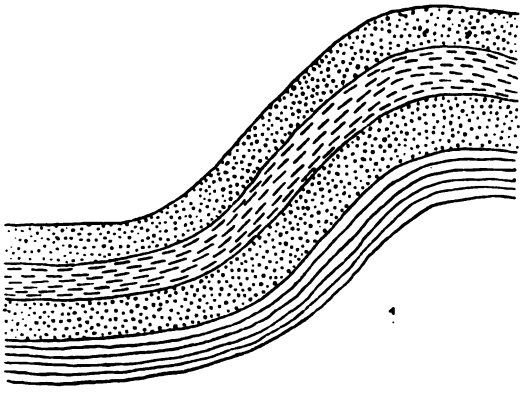
Sedimentary rocks containing:—

1. Sufficient organic materials to form the oil and gas.
2. Porous strata or reservoir rocks in which the oil may accumulate.
3. An impervious cover to prevent the escape of oil and gas.
4. Suitable geological structure permitting the concentration of the oil and gas into commercial supplies.

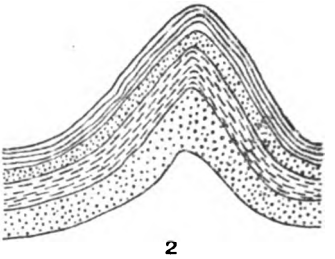
Age of Oil and Gas Deposits.—Oil and gas deposits are not confined to rocks of any particular geological age, and commercial pools have been found in strata ranging from Cambrian to Recent. Rocks earlier than Cambrian, however, do not contain petroleum.

The Palæozoic oil deposits of North America occur in sediments usually unbroken, nearly horizontal, and but little disturbed. The extensive oil-fields of Ohio and Indiana are contained in Ordovician strata having a dip of from 1 to 10 feet per mile. Generally it may be said that the older the geological

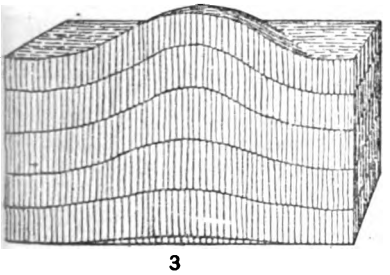
Digitized by Google



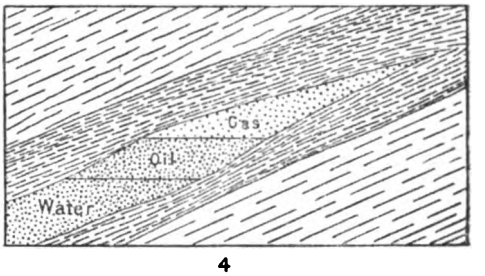
1



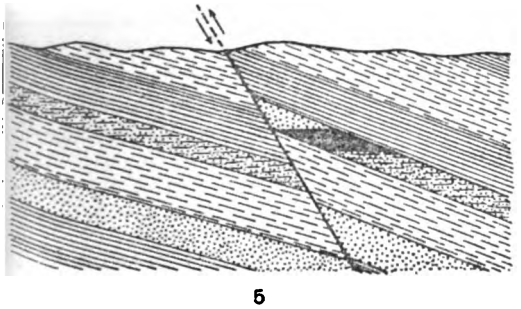
2



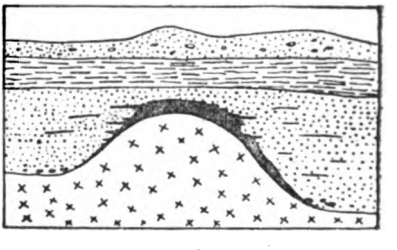
3



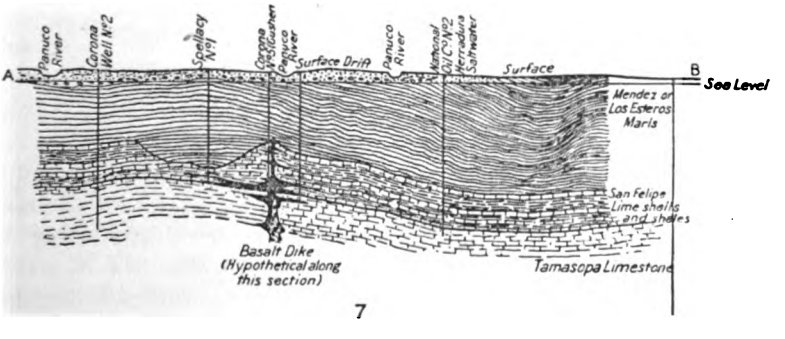
4



5



6



7

Fig. 1.--Monocline.
" 2.--Symmetric Anticline.
" 3.—Dome, becoming flattened at depth.
" 4.—Accumulations in lenticular sands,
Fig. 5.—Oil pool sealed in by fault.
" 6.—Gas pool at unconformity. New York (after Clapp).
" 7.—Section through Mexican oilfield.
(Figs. 1, 2, 4–7 from Ziegler, Popular Oil Geology, 1918).

Digitized by Google

formation the less likely it is to contain oil or gas, and the more often a given area has been subjected either to folding and compression or broadly warping movements, the more certain it is that all or most of the volatile hydrocarbons have been dissipated or reduced to fixed carbon.

Most of the great oil-fields of the world are situated in strata not older than Cretaceous. Several reasons may be advanced to account for the general absence of oil and gas in the older rocks, viz. :—

1. In strata older than Cretaceous the disturbance of the stratification by folding, faulting, and fracturing has usually been profound.
2. Exposure to denudation may have been very prolonged.
3. May be buried to great depths by subsequent accumulations and brought within areas of great heat and pressure.

All of which would tend to dissipate any oil or gas that the sediments originally contained.

Tertiary rocks yield over 50 per cent. of the world's present production of oil.

Digitized by Google

CHAPTER IV.

PROSPECTING FOR OIL.

Marine, estuarine, or lacustrine deposits containing abundant organic remains and including beds of porous rocks embedded in a thick series of impervious shales are favourable to the occurrence of oil and gas, and should be looked for when prospecting for oil. Having located such a series of rocks, a search must then be made for indications of the existence of petroleum. If such be found a careful study is made of the strikes and dips of the beds in order that a favourable structure—preferably a "dome" or "anticline"—may be located on which boring operations should then be carried out. In no case is boring justified until there is definite proof, or justifiable expectation by reason of correlation with other areas, that oil-bearing strata will be encountered.

When prospecting in a country possessing productive oil-fields, the usual practice is to first make a detailed study of the known occurrences—their geological age, the lithological characters and sequence of the rocks, paying particular attention to the occurrence of persistent horizons or "key" beds, and their relative positions with regard to the oil-bearing horizons. The knowledge thus acquired is applied to other regions, and preliminary prospecting consists in searching for fossils, "key" beds, &c., with the idea of locating the same petroleum series. Such data are much more reliable, and enable commercial pools of oil to be located with greater certainty, than when only information concerning surface indications are available.

Prospecting for oil in New South Wales where evidence of the occurrence of oil-bearing strata is lacking, is a very different proposition. Our efforts should first be directed to proving the existence of petroliferous beds, and the cheapest and quickest way of doing this is by making close examination of suitable sedimentary rocks for surface indications of the existence of crude oil.

Surface Indications of Petroleum.

The following are among the most important of the surface indications of petroleum :—

1. Seepages of oil.
2. Outcrops of bituminous rocks.
3. Asphalt and paraffin deposits.
4. Gas emanations.

1. *Seepages of oil.*—Seeps of oil may be the result of oil oozing from the outcrop of oil-sands or may be oil that has reached the surface from a considerable depth by rising along a joint or fracture plane.

Frequently the seeps are associated with asphaltum or ozokerite, residues left by the evaporation of the more volatile constituents of oil. Occasionally gas emanations accompany the oil seeps.

The iridescent films of oxide of iron on water are frequently mistaken for oil.

Digitized by Google

Cunningham Craig, in a report on the petroleum prospects in the Union of South Africa,* gives the following description of iridescent scums of oxide of iron, and how they can be distinguished from oil films :—

> "On marshy ground iron compounds in the strata frequently brought into solution as the soluble bicarbonate through the action of vegetable matter, and this bicarbonate on exposure to the air on mossy surfaces, or on the surface of water, decomposes, forming an iridescent film of ferric hydroxide, which often gives an oily appearance to the water. . The iridescent colours are chiefly reds, red-browns, and blues, and as the film dries it acquires a semi-metallic lustre, while if disturbed it breaks up into sharp-edged and sharp-cornered fragments, though the film may form again if allowed to remain quiescent. Small crystalline flakes may be seen to sink when a partially dried-up film is agitated. . . A film of petroleum on water is also beautifully iridescent, but the colours are chiefly vivid greens, pinks and purples, quite distinct from the colours of the hydroxide films. On being agitated a petroleum film never breaks into fragments with sharp edges or corners, but gives rounded, curved, and convoluted figures. Thus there should be no difficulty in distinguishing the two phenomena."

2. *Outcrops of bituminous rocks.*—These consist of outcrops of sand, sandstone, or other sedimentary rock, stained or impregnated with crude oil or bitumen.

3. *Asphalt and paraffin deposits.*—Asphalt, paraffin, and related bitumens, occur impregnating sedimentary rocks or forming lake-like deposits.

Dense black animal excreta, frequently to be seen in limestone caves and apparently oozing out of the solid rock is frequently mistaken by prospectors in New South Wales for apshaltum, but if a lighted match is applied to a thin splinter of this material the nauseating odour will enable it to be distinguished from the pleasant aromatic smell that characterises asphaltum.

Asphaltum if gripped tightly in the fingers for a few minutes will adhere to them; this serves as a ready test to distinguish it.

4. *Gas emanations.*—Petroleum contains a good deal of dissolved and occluded gases. Frequently the gas, which is under considerable pressure, migrates beyond the confines of the oil-field, so that natural gas (wet) springs do not necessarily imply the occurrence of petroleum in their immediate neighbourhood, but it is reasonable to expect to find oil within the lateral range of the formation carrying the gas. Gas emanations may be derived from decomposing coal-beds, in which case the gas will be "dry," and consist essentially of methane (CH_4) and distinct from "wet" gas, derived from oil, which in addition to methane carries ethane (C_2H_6), ethylene (C_2H_4), and hydrogen (H) in appreciable quantities.

"Dry" gas emanations encountered when boring through coal-seams, or the bubbles of marsh-gas (methane), generally to be seen in any stagnant pool where swamp vegetation grows, or in a watercourse in which drifted vegetable matter accumulates and becomes covered by muddy sediments, are not indications of the occurrence of petroleum.

Recent text-books on petroleum imply that but little reliance is to be placed on surface indications when searching for commercial pools of oil, and Cunningham Craig,† in order to stress this point, states "that many of the

*Mining Journal, London, Vol. CIV, 1914, p. 313.
† Oil Finding, p. 143.

Digitized by Google

best oil-fields in other parts of the world have not a single surface indication of oil on the length and breadth of the field." This statement of Craig's has been quoted locally and interpreted as justifying haphazard boring for oil. The occurrence of seeps of oil or gas, bituminous rocks, or asphalt and paraffin deposits are absolute proof of the existence of oil-bearing strata, but they do not necessarily indicate the occurrence of commercial supplies of petroleum in their immediate vicinity, and further investigations of geological structures must be made before drilling is undertaken. Such surface indications of the occurrence of petroleum are present on most of the productive oil-fields of the world, but there are a few producing areas where such indications are lacking. On such fields, if the oil has not been discovered accidentally, it was tapped as the result of careful geological examination and mapping, and the correlation of beds with *known* oil-bearing areas. The large and important oil-fields of Oklahoma, U.S.A., is a case in point. Here there was an absolute lack of surface indication of oil, and the prospectors of the field drilled wells far away from proven territory, but they drilled with the knowledge that beds of a certain age—elsewhere productive of oil—would be penetrated within certain reasonable vertical limits—and were successful.

A. Beeby Thompson* draws attention to this "tendency in modern literature to disparage the value of surface indications," and he points out that "it is amidst the greatest surface manifestations that many of the most important oil-fields of the world are located. Until recent years when detailed geological surveys of oil regions have been undertaken and the sequence of beds established by palæontological study, locations were largely determined by surface indications.

Supposed indications of petroleum.—The following are among the most important of the evidences that at one time were thought to be indications of the occurrence of oil:—(1) Rock-salt, (2) mud-volcanoes, (3) oil and gas showings in wells, (4) salt water, and (5) oil-shales.

1. *Rock-salt.*—The occurrence of rock-salt was at one time looked upon as a favourable sign of the presence of oil. Rock-salt forms the cores of the numerous domes in Texas and Louisiana in the United States, from which vast supplies of petroleum were obtained. In other localities petroleum and rock-salt are associated and appear to be directly connected. The existence, however, of extensive masses of rock-salt unassociated with oil and the many occurrences of oil without rock-salt, proves that it has no value as indicating oil occurrences.

2. *Mud-volcanoes.*—The association of mud-volcanoes with oil-bearing regions is very marked in Russia and India. These, however, are evidence of the existence of natural gas rather than oil, which may or may not occur in the neighbourhood.

3. *Oil and gas showings in wells.*—Zieglerf points out that "oil and gas in small quantities may be disseminated through all marine shales, and may be localized occasionally in small porous streaks under conditions where no commercial quantities could be expected. A showing of small quantities of either oil or gas in a well is, therefore, not a necessary proof of the existence of, or of approach to, an oil-pool."

* Oil Field Development, p. 209.
† Popular Oil Geology, pp. 114, 115.

Digitized by Google

4. *Salt-water.*—Salt-water is generally met with in oil-wells, and a belief arose that the presence of salt-water indicated the proximity of petroleum. This is by no means true as innumerable examples exist of the occurrence of salty-water unaccompanied by oil.

5. *Oil-shales.*—The similarity between petroleum and the oils obtained by the destructive distillation of oil-shales is responsible for the prevailing idea that oil-shales in some way indicate the presence of petroleum.

Cunningham Craig* points out that " oil-shales and petroleum are entirely separate and distinct phenomena. An oil-shale does not contain crude petroleum, but a series of substances of organic origin classed conveniently under the head of ' Kerogen,' from which oil can be distilled, in a suitable retort. Thus the occurrence of oil-shale is no indication of petroleum, and may have little or no bearing upon the question of the possibility of discovering oil."

That the oil is not present in a free state in the rich Wolgan and Hartley Vale kerosene shales, which yield on distillation up to 130 gallons of oil to the ton, is evidenced by the fact that these shales are not greasy or oily in appearance or touch, and that oil seeps are unknown throughout the extensive outcrops and workings.

* Petroleum Prospects in the Union of South Africa, Mining Journal, London, Vol. CIV, 1914, p. 317.

Digitized by Google

CHAPTER V.

DRILLING FOR OIL.

Commercial supplies of oil are obtained by drilling. Several methods of drilling have been adopted, the most important being:—

1. Percussion (Cable-tool, American), (Pole-tool, Canadian).
2. Percussion with hydraulic circulating attachment.
3. Hydraulic rotary.
4. Combination—Percussion and hydraulic rotary.
5. Core drills—Diamond or chilled shot crowns.

By far the most popular and widely adopted system of drilling for oil has been the percussion method in which a string of heavy boring tools attached to a wire cable is alternately dropped and raised so that repeated blows will be delivered to the formation through which the well is being drilled.

The Canadian system differs slightly from the American in that rods are attached to the string of tools instead of wire cable.

The second method—percussion with hydraulic-circulating attachment—is used for boring in places where it is necessary to use mud for holding up the walls of the hole.

A circulating head is attached to the casing which is being placed in the hole and closely follows the progress of the bit. By means of the circulating head mud is pumped through a hose down through the casing, out the bottom and up along the sides of the hole. This method is of necessity a very slow one.

The Hydraulic Rotary.—In this method a number of lengths of pipe are screwed together and attached to the bottom is a bit, with rotating cones possessing a great number of cutting edges. The power is supplied by pumps having a capacity of about 200 gallons per minute at 150–200 lb. pressure per square inch.

The Combination Method merely combines the cable-tool (percussion) and hydraulic rotary systems.

The Core Drill, in which the cutting is done by diamond or chilled shot crowns attached to the end of the core-tubing, and driven by steam, compressed air, or hydraulic power, is not in favour by oil-field operators owing to its prohibitive cost.

Water in Wells.

Water, usually salt, is invariably associated with petroleum. Fresh water is often encountered at shallow levels from surface percolation and deep-seated salt water below.

When not in excessive quantities in a producing well, separation can be effected by drawing off the water from the bottom of a receiving tank; but when mixed with oil under strong gas pressure an emulsion is formed which

Digitized by Google

can only be separated by distilling. Naturally the presence of water in an oil-field increases the cost of drilling, for each water-bearing bed must be shut off by casing. Failure to shut off water eventually ruins the well, and may cause great damage to neighbouring wells. Whilst the gas pressure is high, water is prevented from entering the well, but damage follows reduction. The water flows behind the casing into the oil-sand, which it impregnates and dilutes to a large extent.

When boring for oil in unproven country each water horizon encountered must be cut off, otherwise, with inexperienced oil-drillers, oil-bearing strata may be passed through unnoticed. The pressure exerted by water in a bore is approximately 42 lbs. per square inch per 100 ft. of depth, so that the water filling a bore 4,000 ft. deep would be exerting a pressure of roughly 1,680 lbs. per square inch.

If a rock-bed is struck containing oil or gas under less pressure than that exerted by the column of water in the bore, then the water from the bore will prevent the escape of the oil and gas, and will rather tend to drive it back.

However, with each withdrawal of the tools or bailer the pressure of the bore water is momentarily reduced, and if appreciable amounts of oil and gas are present in the beds bored through, small quantities, sufficient for determination, will follow the tools or bailer and ascend.

Digitized by Google

CHAPTER VI.

REVIEW OF OIL PROSPECTING OPERATIONS TO DATE IN NEW SOUTH WALES.

There have been many rumours of the occurrence of oil at different localities in the State, and in some districts, *i.e.*, Grafton, Coombell, Richmond, and Penrith, such reports have been current for years. Though small traces of oil have been discovered at Richmond, Penrith and Coombell, and inflammable gases at Grafton, Ravine, Penrith, and in a few bores in the north-western portion of the State, there has been but little justification for most of the reported discoveries.

Investigation by an officer of the Mines Department generally proves that a scum of oxide of iron on water has been mistaken for mineral oil; reported emanations of gas are generally found to be marsh gas, tapped by a bore passing through carbonaceous strata or bubbles of this gas derived from decaying vegetation in stagnant pools; the supposed asphaltum generally proves to be animal matter.

Other reported occurrences of oil are based on opinions expressed by well-sinkers, and are generally without evidence of any kind to support them.

Though there has been but little prospecting work done actually searching for oil in New South Wales, there have been innumerable bores drilled throughout the State for water or testing coal beds that have proved the non-existence of oil in the strata drilled.

Inflammable gas has been recorded in a few of the bores sunk for artesian water in the north-western part of New South Wales, but no trace of crude oil was found.

The Grafton bore sunk to test the water-bearing nature of the Trias-Jura Clarence Beds, struck inflammable gas, and was subsequently reported to have yielded traces of oil.

Several bores sunk through Triassic beds prospecting the Coal Measures beneath, have reached considerable depths, and though these failed to disclose any trace of oil, it must be remembered that they were sunk without water-horizons being cut off and consequently only oil existing under high pressure would show in such bores.

Bores devoted solely to attempts to locate oil and gas occurrences have been drilled at the following localities:—One at Ravine, three at Redbank (near Richmond), one at Penrith, and two are now being bored—one near Scone and the other at Yerrinbool.

The following notes deal with the prospecting work done and investigations carried out by officers of the Mines Department at the sites at which indications of oil have been reported to exist.

1. Ravine, Lobb's Hole, Yarrangobilly.

Some years ago an inflammable gas was found issuing from gently-inclined Silurian rocks in the workings of the Lobb's Hole Copper Mine, situated at Ravine, in the valley of the Yarrangobilly River.

Digitized by Google

Mr. J. B. Jaquet drew attention to this occurrence and pointed out its possible economic significance.*

Samples of the gas were obtained and analysed in the Department's laboratory, by Mr. H. P. White, Assistant Analyst, with the following results:—

Gas Analysis.

	Samples.	
	No. 1.	No. 2.
	In 100 volumes.	
Carbon dioxide (CO_2)	5·00	4·33
Ethylene (C_2H_4)	absent	absent.
Oxygen (O)	0·50	0·16
Carbon monoxide (CO)	absent	absent.
Methane (CH_4)	40·33	30·20
Hydrogen (H)	absent	absent.
Sulphuretted hydrogen (H_2S)	„	„
Nitrogen (N)	54·17	65·31

"The gas is odourless, burns with a light blue flame, and when mixed with twice its volume of oxygen explodes."

The absence of the higher hydro-carbons and hydrogen would indicate that this is not an oil gas.

In 1917 aid from the Prospecting Vote was granted by the Mines Department to test this occurrence by boring, which it was hoped would serve the dual purpose of proving the possibilities of the existence of commercial supplies of gas or oil and locating the position of a copper lode. Boring was continued to a depth of 763 feet without disclosing a single trace of oil or an increase in the volume of gas, and was discontinued as the cavernous limestone rendered operations impracticable.

Mr. J. B. Jaquet, Chief Inspector of Mines, in a report on the boring operations at Ravine, states:—

> "From the surface down to a depth of 676 feet, slates, traversed by quartz veinlets, and containing a little pyrites, were encountered, and between this depth and 697 feet calcareous slates. At 677 feet a copper lode was met with. . . The borehole was continued below the lode through limestone rock containing widely-separated small splashes of copper-pyrites and galena down to a depth of 763 feet.
>
> "Upon arrival at Ravine I fixed an appliance on the stand-pipe of the borehole with the object of determining whether any gas was issuing from it. I found that during three days about a quarter of a litre of either gas or air issued from the borehole. The quantity obtained was too small to test chemically . . . if any gas be issuing from the borehole at the present time the volume of it is extremely small."

In 1901, Mr. E. C. Andrews, Government Geologist, reported† that "The Lobb's Hole Copper lode occurs in the bed and alongside of the Yarrangobilly River, the latter lying in a gorge exceeding 3,000 feet in depth; the country consisting of quartzite breccias, and siliceous argillaceous strata, overlain

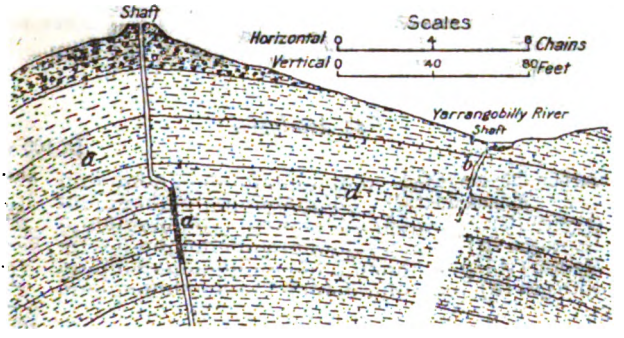
* Annual Report, Dept. Mines, for 1908, p. 70. † *Ibid.* 1901.

Digitized by Google

by conglomerate, sandstone, quartzite, limestone, and slate of the same age. Folding is pronounced; the strata at the mines forming a dome-shaped mass possessing an almost horizontal dip, but inclined in all directions from this spot as centre."

The following section across the copper lode is taken from Mr. Andrews' report:—

Sketch Section across the Lobbs' Hole Copper Lode.



a. Reeckmann and Forrestrom's lode.
b. Kerry and Forrester's lode.
c. Breccia.
d. Siliceous variety of argillaceous rock.

Most of the essential conditions for the occurrence of commercial supplies of gas and oil are present at this site. Organic remains are fairly abundant in the limestone and shale; sandstone and conglomerate to act as reservoir rocks occur intercalated with impervious quartzite and slate; and finally the most favourable of geological structures—a dome—is present to serve for the concentration of the oil and gas.

Perhaps these beds never carried supplies of oil and gas, but again it is possible that they may at one time have done so, but, owing to the great geological age of the strata, the folding, fracturing, and faulting that has taken place, and the metamorphism the rocks themselves have undergone, all traces of oil have been eliminated.

2 and 3. Redbank, near Richmond, and Penrith.

2. *Redbank.*—Early in 1910 it was reported that indications of the occurrence of natural oil and gas had been discovered near Richmond. Some time later a hand drilling plant was rented from the Mines Department to prospect for oil. Boring was commenced at Redbank close to the Kurrajong road, and it was subsequently reported that at a depth of 241 feet the boring rods were covered with an oily slime. Mr. J. B. Jaquet, Chief Inspector of Mines, inspected the bore and reported that "he did not find any signs to indicate that deposits of petroleum are likely to be found there."

An application for Government aid to continue boring at this site was refused.

Digitized by Google

In 1911 Mr. J. C. H. Mingaye, Government Analyst and Assayer, inspected this bore and reported that it was then 252 feet deep, with water rising to within 14 feet of the surface. Mr. Mingaye procured samples of the water and gas from the bore hole, and of the gas from "gas springs" (?) in Redbank Creek, and subsequently reported :—

"The water from the bore showed no signs of oil floating on the surface, or any indications or traces of petroleum oil in the bore.

"Specially prepared gas-collecting apparatus was lowered into the bore, and it was observed that little or no gas was given off, it taking three hours to obtain about 200 c.c. of gas in the sample bottle. An analysis yielded :—

Gas Analysis.

	In 100 volumes.
Carbon dioxide (CO_2)	absent.
,, monoxide (CO)	,,
Oxygen (O)	20·00
Hydrogen (H)	absent.
Methane (CH_4)	,,
Nitrogen (N)	80·00
	100·00

"Gas from fissure in rock, Redbank Creek, near bore, North Richmond.

"The gas bubbles given off were very intermittent, but I am informed that it bubbles strongly at times in the pool. The time taken to fill a bottle holding about 300 c.c. was one hour.

Gas Analysis.

	In 100 volumes.
Carbon dioxide (CO_2)	11·66
,, monoxide (CO)	absent.
Oxygen (O)	,,
Hydrogen (H)	,,
Methane (CH_4)	,,
Nitrogen (N)	88·34
	100·00

"From a careful inspection of the bore no signs of petroleum oil were visible, and it is highly improbable that natural petroleum oil will be found in this district."

A second bore (known as the No. 2 or deep bore) was begun about 25 yards away from the first bore and drilled to a total depth of 877 feet without revealing any of the heavy oil reported as having been struck in the first bore.

Some time later a third (No. 3) bore was commenced at a site about 90 yards distant from the No. 2 bore and close to the Redbank Creek Bridge.

A heavy oil was reported as having been encountered in this bore at 200 feet.

Mr. Carne, late Government Geologist, in a report dealing with the indications of oil and gas and boring operations at this site, points out that the so-called gas-springs could be seen by "stirring the mud in the bottom of isolated, stagnant, shallow pools in Redbank Creek, bubbles of marsh

Digitized by Google

gas being then freely given off and which flashed on application of a lighted taper; this, however, is a common characteristic of marsh gas, which is generated wherever decomposition of vegetable matter takes place under mud and water."

The only case of an undoubted oil-scum in the creek seen by Mr. Carne was obtained after stirring the mud at the bottom of a shallow pool round the base of the timber trestles supporting the bridge, but this had probably been derived from creosote oils with which the timbers of the bridge had been recently treated and was thus a very doubtful indication of the existence of crude oil.

The No. 2 bore was inspected by Mr. Carne on the 13th January, 1916, and he reported:—

"After the bailer had been worked up and down for a brief period, a sample from the top of the water was then lifted which in certain lights revealed faint iridescence in small spots, but too faint for definite determination as 'oil' or not."

Mr. Carne subsequently inspected the No. 3 bore and reported:—

"On 1st December (1916, L.J.J.) Mr. Mingaye and I again visited Redbank Creek at the request of Mr. Duke to investigate the discovery of a heavy oil in his No. 3 bore, then down 460 feet. It was noted that the top of the bore casing was covered with an iron cap and padlocked, as operations had ceased for some time. Mr. Duke reported that the water in the bore was influenced by the level of the water in Redbank Creek, distant only a few yards. The water in the bore was then standing about 18 feet below the top of the casing. On raising some of the water no trace of oil was visible, but on agitating it by running the bailer to the bottom several times and again raising some of the surface water a slight undoubted oil-scum was visible.

"Mr. Duke states that he saw no trace of oil above 200 feet, nor would any appear on the centre rope of the boring tool even if lowered to the bottom. But with the bailer-rope running on the side of the casing, a heavy greenish oily substance appeared on the rope below 200 feet, evidently scraped from the inside of the casing. A sample of this was obtained from the rope in my presence by Mr. Duke's assistant, by forming a ring with his fingers and thumb round the rope and thus scraping the oil off and into a small wide-mouthed sample bottle, about 1½ oz. thus being obtained."

Mr. Mingaye in a report describes the substance obtained from the bailer-rope as "resembling a heavy fat, of a density heavier than water, as when detached from the bottle, to which it closely adhered, and dropped into water, it at once sank and remained fast on the bottle."

"The water covering this material showed a slight oily film and fluorescence on the surface characteristic of petroleum oil.

"The dry material on treatment with benzine and absolute alcohol yielded a dark brownish-red fluid and a mineral residue still containing some organic matter other than oil.

Digitized by Google

"The solution obtained was evaporated at a low temperature, and on the removal of the benzine and alcohol yielded a heavy viscous oi answering all the characteristics and tests for petroleum oil. Abou 1½ oz. of the oil was obtained. The black residue consists largely o fine clay, some free silica (sand), and organic matter.

"The substance as received contains as follows:—

No. 3263/16	
Loss at 100°C	14·15
Oil	43·18
Mineral matter	34·90
Organic matter (other than oil)	7·77 (by dif.)
	100·00
Calculated on the dry material.	
Oil	50·29
Mineral matter	40·65
Organic matter (other than oil)	9·06 (by dif.)
	100·00
Specific gravity of oil	0·920 at 60° F.
Saponification value	1·42 % of KHO.
Iodine absorption (Hubl)	6·68
Refractive index	1·495 at 20° C.

"The oil belongs to the paraffin or saturated series, but probably contains a small amount of unsaturated hydrocarbons (Olefines). This is indicated by the iodine absorption.

"NOTE.—Any lighter oils present in the sample would have been lost in treatment of the material with solvents and subsequent evaporation.

"The tendency of the heavy viscous substance to sink in water and attach itself to the iron tubing is due to the oil having formed an emulsion with the fine mineral matter and water, in which it is intimately bound, and at the ordinary temperature unable of flowing, and thus rising to the surface of the water.

"A. Beeby Thompson* points out: 'The aeration and violent agitation of oil and water in certain proportions leads to the occasional formation of emulsions, some of which defy all simple means of separation. Some emulsions are discharged from the air-lift in congealed grey masses of the consistency of butter, whilst others are fluid and have the consistency of cream. Many such emulsions liquefy and separate in a few minutes, but some containing 30 per cent. of water neither separate after lengthy settlement in open tanks, or even permit of any mechanical separation. This class of emulsion is not common, and usually producers are not much troubled by its formation.'

"In this case the emulsion appears to be due to the action of the percussion drill on the rock material and the presence of a heavy viscous oil, probably water has played its part; the drill has so beaten the oil up with the fine shale, &c., as to thoroughly emulsify it and so form the substance found in the bore.

* Petroleum Mining, p. 298.

Digitized by Google

"Almost all water contaminating oil formation are more or less saline. . . . . The water from No. 3 Redbank bore does not show any special degree of salinity. Total solid matter was found to be 28·448 grains per gallon. Chlorine combined as chlorides, 10·874 grains per gallon. As this bore is below the level of the creek it is possible that fresh water is finding its way into the bore."

Mr. Carne's report continues :—

"In regard to the heavy oil adhering to the inside of the casing of the latest bore (No. 3) near Redbank Bridge, which sinks in water, it is very probable, as suggested by Mr. Mingaye, that its density is due to an emulsion being formed with fine mineral matter and water by the action of the percussion drill, the analysis revealing 34·9 per cent. of mineral matter—fine shale.

"The emulsions frequently resulting in oil-fields through neglect to shut off water in boring are the result of enormous gas pressure. The gas pressure (principally nitrogen) in the natural springs and in the deepest bore at Redbank is practically negligible as can be judged from the time occupied in collecting an almost infinitesimal quantity, whereas the pressures recorded in the well-known oil-fields of the world frequently register over 500 lb. to the square inch when first encountered."

Mr. Carne draws attention to "samples of shell grit kneaded with pure white paraffin wax" sent to the Department of Mines purporting to be "sand from oil-bearing strata at Kurrajong," near Richmond. This material was palpably different from the Ostracod-bearing calcareous rocks at Kurrajong :—

"Mr. W. S. Dun, Palæontologist to the Geological Survey and Lecturer in Palæontology to the Sydney University, who examined these samples, reported as follows :—

Sand said to come from oil-bearing strata, Kurrajong. This entirely differs from the Ostracod-bearing calcareous rocks at Kurrajong, and a small amount was submitted to Mr. F. Chapman, Melbourne, who says: "I found a few remains of living organisms, amongst them being *Polystomella Crispa* living in beach sands. Your sample is a shore sand, mainly calcareous, consisting of well-rounded chips of shells and a few foraminifera—age yesterday."

"The Ostracod-bearing calcareous rock above-mentioned forms a thin stratum in the upper portion of the Wianamatta Beds, below Box Hill, and for a short distance along the Grose Vale road.

"Mr. Dun states :—

The calcareous sandstones at Grose Vale contain both Foraminifera and Ostracoda. These have been described by Mr. F. Chapman, of the National Museum, Melbourne, a well-known authority on these groups of micro-organisms, who remarks: "These undoubtedly represent a brackish or estuarine fauna, having a curious intermingling of Rhætic or Lower Jurassic types, with others more properly referable to the Upper Palæozoic of Europe." (Records Geol. Survey, New South Wales, VIII, 1909, p. 335, pl. 54.)

Mr. Carne's report concludes :—

"So far the deeply dissected Blue Mountain Plateau—on the eastern margin of which the present reported indications occur—has yielded no evidence of oil or deep-seated gas springs even where dissected from the Middle Mesozoic to the Devonian; nor have any of the coal shafts,

Digitized by Google

tunnels, or drill bores revealed any other than the usual gas associates of coal. Naturally the deepest workings—as at Balmain, Helensburgh, &c.—are gaseous owing to the escape of occluded coal-gas.

"Nor yet have any inspissated products of oil such as ozocerite (mineral wax), bitumen, &c., been observed.

"The one feature, if supported by collateral evidence, which would have a bearing on the probability of oil at Redbank, is the monoclinal fold into which the strata are curved along the eastern face of the Blue Mountains between Wheeney Creek and Burragorang Mountain (approximately). The fold, however, has been dissected to considerable depths by eastern flowing streams crossing it from the Blue Mountain Plateau without any evidence than that recorded at some length herein.

"I am bound, however, to express my belief that even if oil be obtained here it will prove to be in extremely small quantity."

3. *Penrith.*—Early in January, 1917, Mr. Carne, in company with Mr. Mingaye, Government Analyst and Assayer, inspected the supposed indications of the occurrence of oil in the neighbourhood of Penrith, about 15 miles south of Richmond, and reported that the evidence "consisted of marsh gas, and an oily scum rising to the surface of the water near the river (Nepean, L.J.J.) bank on stirring the mud at the bottom, and in crevices of an apparent rock ledge." He urther reported:—

"Unfortunately for definite determination, the site is vitiated by the fact that it is situated at a long-used boat landing, near the railway bridge over the Nepean, which is much used by the local motor-launch proprietor, whose boats are tied alongside, whilst the landing-stage bore a number of oil tins—some partly filled.

"The gas indications were most abundant in the vicinity of rushes and other water growths along the banks.

"In 1912, similar reported sites of oil indications were visited by Dr. R. Logan Jack (formerly Government Geologist of Queensland) and Mr. J. Edwards, of Attunga, 10 miles higher up the river. Four samples of gas were subsequently tested for them by Mr. Mingaye, who failed to detect any marsh gas in them . . . . The gases determined were:—

Nitrogen	77·16 to 78·67 per cent.
Oxygen	12·84 to 16·00 ,,
Carbon dioxide	5·33 to 12·16 ,,

In 1918 boring operations were started by the company at a site about 4 miles south-west of Penrith. Application for government aid to continue boring was made by this company, but as the prospects of striking commercial supplies of either oil or gas appeared so remote, the application was refused.

The company eventually continued boring to a depth of approximately 2,700 feet without disclosing commercial quantities of oil.

Digitized by Google

The following report by Mr. Mingaye, Government Analyst, and the writer was made when boring operations were just ceasing :—

Oil Boring at Penrith.

(Messrs. Mingaye and Jones.)

"Mr. Mingaye and I inspected the boring operations near Penrith, and obtained a sample of the gas. The bore is situated within portion 39, Parish Mulgoa, County Cumberland, close to the Mulgoa-road, and about 4 miles south-west of Penrith railway station. The altitude of the bore site is approximately (aneroid) 175 feet above sea-level. The bore is reported to have reached a depth of nearly 2,700 feet, and a seam of coal 12 feet in thickness is stated to have been penetrated at a depth of 2,523 feet. Traces of oil and a large volume of gas are reported to have been met with. Several water-bearing horizons have been struck in sinking the bore, some of which have been properly shut off. The log of the bore was not available for our inspection, and a personal request to the company for it was refused.

"The company have spent a considerable sum of money in boring here without locating commercial quantities of oil, and are not disposed to incur the heavy expense of unwatering the borehole in order to thoroughly test the gas. Before withdrawing the casing and abandoning operations here, the company suggest that the Government undertake the unwatering of the borehole and ascertain the quality and volume of the gas. The company are prepared to place their machinery at the disposal of the Government if the necessary pumping apparatus is supplied. The pump would have to be provided with 2,600 feet of tubing and rods, maximum dimensions not to exceed 4½ inches, and be capable of lifting 1,000 gallons per hour.

"At the time of our inspection the water was within 30 feet of the surface in the bore, preventing the gas which was encountered near the bottom from rising to the surface. In order to provide a sample of the gas, it was necessary to agitate the water by dipping the bailer to the bottom of the hole, when the gas was then freely given off.

"A good sample of the gas was obtained which, on analysis, yielded :—

Gas Analysis.

No. 2192/1920—	In 100 volumes. per cent.
Carbon dioxide (CO)	13·33
,, monoxide (CO)	1·16
Oxygen (O)	5·16
Unsaturated hydrocarbons (Olefines, &c.)	0·00
Methane (CH_4)	47·72
Hydrogen (H)	Nil.
Nitrogen (N)	32·63
	100·00

"It will be observed that 1.16 per cent. of carbon-monoxide was found in the gas. This is probably an impurity, and not present in the gas as it flows from the bore, as before the sample was taken the gas was ignited at the top of the bailer with a view of ascertaining if gas was coming off.

Digitized by Google

"Before taking the sample, water was bailed out of the bore, and the bailer lowered two or three times to the bottom of the bore, and brought up again, but it is evident that a small amount of carbon-monoxide formed from the burning of the gas had still been left in the bore.

"In our opinion the gas is what might normally be expected to be given off from the coal penetrated by the bore and not from oil-bearing strata, we do not see our way to recommend that the Government incur the expense of unwatering the borehole to further test the gas."

The two localities—2. Redbank (Richmond) and 3. Penrith, 15 miles south—are on account of their proximity to each other and the similarity of geological conditions at each site discussed together.

The following is the sequence of geological formations, in descending vertical order, at both Redbank and Penrith:—

Age.	Strata.	Thickness.
Recent	River alluvium	Up to 50 feet.
Mesozoic	Triassic — Wianamatta Shales	100 ,,
	Triassic — Hawkesbury Sandstone	1,000 ,,
	Triassic — Narrabeen Shales	1,500 ,,
Palæozoic	Permo-Carb. — Coal Measures	800 ,,
	Permo-Carb. — Upper Marines	1,000 ,,

The Recent alluvium and the Wianamatta Shales may, on account of their small development here, be disregarded as possible sources of oil.

The thick and uniform character of the beds comprising the Hawkesbury and Narrabeen Series, consisting of sandstones and shales, devoid of limestone or marly bands, deposited for the most part under atmospheric oxidizing influences, are most unfavourable for the occurrence of oil, and experience in other parts of the world has shown similar rock types to be barren. Not only were the conditions of sedimentation unfavourable for the beds, but they show only scant traces of organisms, either of animal or plant type, so essential for the formation of oil and gas. Moreover, they do not appear to contain beds of sand or sufficiently porous sandstones suitable to act as reservoir rocks. Examination of the great cliff faces of the Blue Mountains illustrates this point. The general impermeability of these beds is demonstrated at the Cataract Dam, and by the existence of numerous large swamps on the plateaux of the Blue Mountains and southern highlands around Bundanoon and Thirlmere.

The Permo-Carboniferous Coal Measure beds undoubtedly contain abundant vegetable remains preserved in the form of coal, but in view of the absence of oil-bearing strata over the wide extent of country where these beds are exposed and developed, the prospects of such being present here are not bright. There is no possibility of crude petroleum being formed from the coal itself, for the carbon-hydrogen ratio is such that it would be impossible to form from it the mixture of hydro-carbon that constitutes crude petroleum.

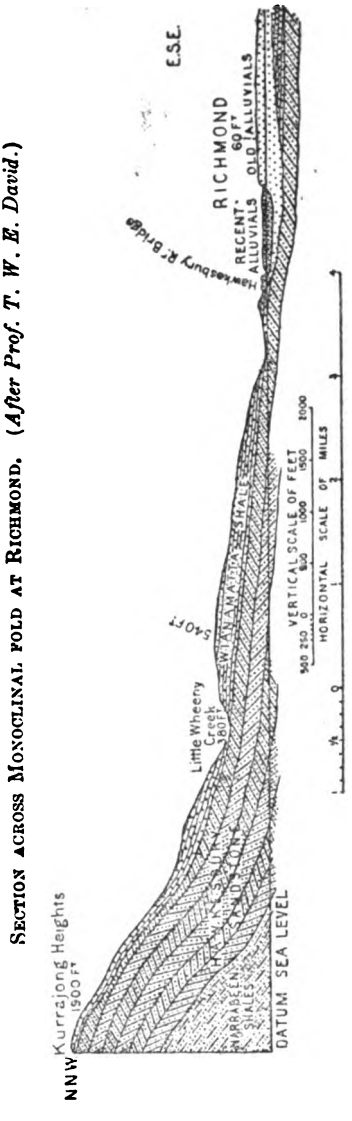
To penetrate below the coal measures a borehole would have to exceed 3,500 feet in this neighbourhood, and until it has been proved that the Upper-Marine beds—which underlie the Coal Measures, and which are extensively developed, at lesser depths, in other parts—are likely to be oil-bearing, boring to test them here is unwarranted.

Digitized by Google

Structure.—The geological structure at Richmond and Penrith illustrated on the accompanying section is that of a monoclinal fold, dipping to the east, with a flattening of such dip farther east again to form a structural terrace. The monoclinal fold at Richmond and Penrith is a structure not unfavourable to the occurrence of oil, provided the oil exists in the sediments.

The only evidences so far disclosed of the existence of oil in these localities are (1) the presence of a little heavy viscous oil in only one of three bores—situated close together—at Richmond; and (2) traces of oil-scums of doubtful origin at Redbank, and on the river at Penrith. The occurrence of "dry" gas in the deep bore at Penrith, undoubtedly derived from the coal seam penetrated at a depth of 2,523 feet, and the marsh gas given off in stagnant pools cannot be said to indicate the occurrence of oil.

Though minute quantities of oil may be encountered in the sedimentary rocks developed in this district, the possibilities of obtaining commercial supplies of crude oil are very remote.



SECTION ACROSS MONOCLINAL FOLD AT RICHMOND. (*After Prof. T. W. E. David.*)

4 AND 5.—GRAFTON AND COOMBELL, RICHMOND RIVER DISTRICT.

4. *Grafton.*—A deep bore, started in 1897, and completed to a depth of 3,698 feet in April, 1902, was sunk at Grafton under the directions of the Public Works Department for the purpose of testing the water-bearing capacity of the Trias-Jura (Clarence) beds in this district. Natural gas was tapped in this bore, and after boring operations had ceased it was reported that indications of oil were to be seen in the waters coming from the borehole.

Mr. Carne, late Government Geologist, furnished the following report of the supposed indications of petroleum at the Grafton bore:—

Reported oil in Grafton bore.

"Reports which have been current, at intervals, for a number of years as to the presence of petroleum oil in a bore at Grafton, have recently been revived; it is therefore desirable that an authoritative statement should be published detailing the facts connected with this bore which was put down by, and under, Government authority.

Digitized by Google

"The bore in the Racecourse grounds at Grafton was put down on the advice of Mr. E. F. Pittman, then Government Geologist, for the purpose of testing the Clarence measures for possible artesian water.

"Boring with a calyx drill was begun on the 13th January, 1897, by Messrs. Crawford and McCray, under contract with the Works Department, and completed by them to a depth of 2,611 feet in August, 1898.

"Subsequently boring was resumed by the Works Department on the 17th November, 1898, by day-labour, and completed to a depth of 3,698 feet by the 12th April, 1902, at which depth the bore was abandoned.

"The official record states that:—Fresh water was met at a depth of about 1,070 feet, which rose to the surface but subsequently receded. Natural gas was tapped at about 3,100 feet. This would ignite at top of casing and send a flame 4 ft. high; at times the flow of gas was very strong and threw water half-way up the derrick.

"Between 2,205 and 2,288 feet coal was met in streaks, and again at 3,366 feet; and at 3,419 feet the seam was 7 ft. in thickness.

"No trace of oil was at any time observed during boring operations extending over five years. Though a little natural gas (methane, or marsh gas) was met at higher levels, it was not until the coal-bearing strata was entered that it became appreciable. The evolution of gas has long since diminished to insignificent proportions, the flame from its ignition at the bore-head now rising only a couple of inches.

"It might be pointed out that whilst natural gas and oil are intimately associated in oil-fields, there are innumerable occurrences of natural gas without such an association. The gas discharged from coal and coaly strata is formed of a considerable proportion of the same hydro-carbon—methane or marsh gas—constituting the greater proportion of natural gas. It is moreover a common product of decomposition of vegetation buried under mud and water—especially in stagnant pools.

"In consequence of the recent revival of reports of the presence of oil in the Grafton bore, the Minister for Mines instructed that tests should be instituted to set the question at rest, thereupon Mr. Inspector Godfrey—of the Mines Inspection Branch—was deputed to visit Grafton and obtain samples of gas, water, and any substance or liquid indicating the presence of oil, to be submitted to chemical investigation.

"Before leaving for Grafton, Mr. Godfrey was supplied with apparatus for sampling by Mr. Mingaye, F.I.C., F.C.S., Analyst to the Department, and especially instructed as to the best mode of procedure in taking samples.

"On the 15th instant Mr. Godfrey reported from Grafton as follows:—

From top of bore-hole pipe to surface of liquid	=	14 ft. 2ins.
From top of bore-hole pipe to obstruction	=	134 ft.

"Water and oil (?) samples taken in two ways:—

1. By means of a sponge in an inverted funnel.
2. By a wide-mouthed pickle jar weighted carefully to cause it to sink very gently under the water, so that the surface liquid flowed gently in.

Digitized by Google

"By neither method could even a trace of oil be obtained, the only foreign material being a black substance which sank as soon as the water became still, and which was probably kept in suspension in the bore by the gas.

"The gas sample was carefully taken with the apparatus supplied by Mr. Mingaye, and the gas was not collected until it had issued from the rubber tube for at least 20 minutes.

"An ignition test made at the top of a glass jet attached to the rubber tube showed a steady flame about 2 inches in length, dark blue at the base, black in the centre, and yellow at the sides and tip—it shows all the characteristics of methane.

"When collecting the gas in the bottles it did not come off continuously, but in bursts with an interval of about 1¾ minutes between each, this being probably due to the face that sufficient pressure had to accumulate after each burst to force the water out of the bottles. If bubbled just under the water it emerged continuously.

"No trace of petroleum or any other oil was obtained, the water being clear except for the black substance, which I assume to be iron rust coated with either vegetable matter or tannic acid."

Of the samples submitted, Mr. Mingaye reported:—No. 3512/16, water and skimmings from top of water in Grafton Bore:—

"The water in the bottle was clear, and contained at the bottom of the bottle a reddish-black deposit, which on examination was found to consist of ferric oxide and carbonaceous matter.

"There is absolutely no sign of petroleum oil in this sample."

Similar results were obtained from a second sample, No. 3513/16.

"Two samples of gas taken from the bore at noon (No. 3510/16), and at 12·45 p.m. (No. 3511/16) were submitted to tests in the Departmental Laboratory, with the following determination:—

Gas Analysis.

	No. 3510/16	No. 3511/16.
	In 100 volumes of gas.	
Methane (CH_4)	62·50	86·95
Ethane (C_2H_6)	Nil.	Nil.
Ethylene (C_2H_4)	Nil.	Nil.
Hydrogen (H)	Nil.	Nil.
Carbon monoxide (CO)	Nil.	Nil.
„ dioxide (CO_2)	Nil.	Nil.
Oxygen (O)	10·66	5·53
Nitrogen (N)	26·84	7·52
	100·00	100·00

"The gas tested at the bore gave no reaction for sulphuretted hydrogen; it does not come off continuously from the bore, and evidently varies in composition as seen by comparison of the analyses of the samples taken within 45 minutes of each other.

"Mr. Mingaye notes that the gas contained in the Grafton and in some New South Wales artesian bores differs from gases found associated with oil in American and other oil-fields by reason of the absence of ethane, hydrogen, and certain members of the olefine series which characterise the latter.

Digitized by Google

"Mr. Mingaye adds further that in his opinion the gas contained in the Grafton bore water has been derived from the coal measures through which the bore has passed.

"The obstruction in the bore at 134 ft. from surface probably caused by something dropped into it, though preventing a vessel being lowered, evidently does not obstruct the flow of gas and water."

5. *Coombell–Richmond River District.*—Reported discoveries of indications of oil at Coombell, in the Richmond River district, in strata of the same age as that occurring at Grafton is the subject of the following report by Mr. J. E. Carne, late Government Geologist (12th December, 1918):—

Reported Petroleum and Kerosene Shale in the Richmond River District.

"At frequent intervals during the past six months references to the occurrence of petroleum oil and kerosene shale have appeared in the local press columns in the above district, with repetition in the metropolitan papers.

"Under instructions from the Minister for Mines the scene of the most recent reports was visited by myself and Mr. Assistant Geological Surveyor L. J. Jones, on 5th, 6th, and 7th instant.

"Proceeding by train from Lismore to Rappville, 8 miles from Coombell, brief examination of the locality was made.

"An early start was made the following morning for the reported kersoene shale deposit at Mount Belmore, in the Parish of Wyon, County Richmond, about 15 miles westerly from Rappville, where, according to Mr. Rapp, he and others drove a short tunnel twenty-seven years previously in a rotten seam of coaly shale under the impression that it might be kerosene shale.

"A very brief examination was sufficient to dispel any hope of such a discovery. The strata here, as throughout the district, forms part of the well-known Clarence Coal Measures, consisting of sandstones and rotten clay shales with characteristic Mesozoic plant remains and complete absence of anything approaching kerosene shale, which hitherto has only been found in Palæozoic strata, associated with our true Coal Measures.

"The following morning Coombell was visited, where Mr. Gunthorpe, Manager of the Coombell Brick Works, rendered every assistance in the examination of the shale quarry, and in securing samples of the reported oil.

"The quarry—about 40 feet deep—is excavated in typical clay shales of the Clarence series, which contain thin streaks of bright friable bituminous coal, the supposed "*bitumen*." A representative sample was submitted to analysis by Mr. J. C. H. Mingaye, F.C.S., F.I.C., Departmental Analyst, with the following result:—

Analysis.

No. 4861.

Hygroscopic moisture	0·26
Volatile hydrocarbons	31·62
Fixed carbon	25·14
Ash	42·98

Some of the finely powdered coal was treated with chloroform and the solution evaporated to dryness at the ordinary temperature of the air to remove the chloroform. No signs of petroleum oil were visible in the chloroform extract.

Digitized by Google

"About 4 feet above the bottom of the quarry on the north side a ledge of clay shale about 3 feet wide has been left, and in this ledge close to the vertical drop to the quarry floor, several shallow vertical holes were punched with an ordinary steel drill. When a few inches had been penetrated the drill hole was filled with water until it overflowed. In the light-coloured slurry thus formed with the powdered shale, streaks, or dark oily looking stains appeared—these have been regarded as oil.

"As they appeared in the drill holes they were skimmed off and bottled and subsequently submitted to analysis by Mr. Mingaye in the Departmental laboratory. Following is a copy of Mr. Mingaye's report :—

No. 4860 (Sample of silt consisting of fine clay, water, &c., 2½ fluid oz.). On treatment of the clayey matter with chloroform an extract was obtained which was evaporated at the ordinary air temperature to dryness in a small glass dish.

A very small residue was obtained which weighed 0·0144 grammes of an oily substance which had the appearance of being petroleum oil, but the amount found is so small that it was impossible to test, and so thoroughly identify the oil for certainty.

The water is a strong brine, consisting largely of sodium chloride.

No iodine or bromine were detected in the water.

"The apparent presence of an infinitesimal trace of petroleum reported by Mr. Mingaye in the sample obtained by me in the Coombell Quarry is not remarkable considering the origin of the fossiliferous clay shales, which were originally deposited in and under mud and water, probably under swampy conditions which prevented escape of the hydrocarbon products of decomposition.

"Though petroleum might be present as a minute trace in the clay shales, I am confident that no commercial supplies of *free petroleum oil* exist in the localities examined, whatever might be obtained from the fossiliferous shales by chemical distillation, the commercial success of which I regard as hopeless.

"It is significant that no trace of oil seepage appears on the quarry walls or floor, nor on the water accumulated on the lower portion of the quarry, though a characteristic scum of oxide of iron covers its surface with the usual iridescent colours."

The reported indications of oil at the Grafton Bore and at Coombell, Richmond River District, are contained in beds of the Clarence series of Trias-Jura age. These beds comprise shale, sandstone, conglomerate, and coal seams, and are of freshwater origin. They have a maximum thickness of 4,000 feet, and occur in the form of a basin in the north-east corner of the State, outcropping over the eastern part of the watershed of the Clarence River and along the coast from Woolgoolga to the mouth of the Richmond River. Northwards they cross into Queensland, and are continuous with the Ipswich beds of that State.

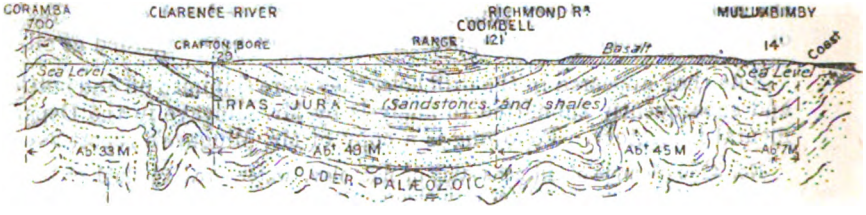
The sandstones of the Clarence series bear a strong lithological resemblance to those of the Hawkesbury series, and are likewise characterised by the paucity of their fossil contents.

Above a thick basal conglomerate five seams of coal occur in the lower portion of this series, ranging from 2 to 37 feet in thickness. These seams so far examined contain too many claybands for economic workings.

Digitized by Google

The following section from north to south across this basin illustrates the general structure and sequence of the beds:—

DIAGRAMMATIC SECTION FROM SOUTH TO NORTH, ACROSS TRIAS-JURA BASIN FROM CORAMBA TO MULLUMBIMBY.



With the exception of the coal-bearing portion of the Clarence beds, organic remains are particularly scarce throughout the series, and they thus are lacking in one of the essential requirements for the occurrence of commercial supplies of oil. The minute traces of what appeared to be oil, recorded by Mr. Carne in the shales of the coal-horizon at Coombell, is, in spite of the extensive area over which these beds outcrop, and of the considerable amount of prospecting work done opening coal seams, the only evidence we have of the oil-bearing nature of these beds.

Throughout the Clarence series porous strata, suitable for reservoir rocks, occur, intercalated with impervious shales which would provide adequate cover for the retention of oil and gas if such existed. The geological structure of the series is simple and not favourable at Grafton or Coombell for the accumulation of commercial oil-pools. Careful detailed mapping of this area would probably reveal localities at which a pronounced change in the amount of dip of the rocks has taken place or local bucklings at which concentration of oil and gas, if present, might take place.

Though these Trias-Jura Clarence beds may possess porous strata suitable to act as reservoirs, protected by adequate cover, and suitable geological structures may be present, still the thick and uniform character of the sediments (most unfavourable for oil accumulation), together with the absence of the necessary organic materials to form large quantities of oil and gas makes hopeless the prospects of obtaining commercial supplies from such beds. Minute traces of oil in strata in no way indicate the proximity, or even the existence, of commercial pools.

6. KINGDON PONDS CREEK, NEAR SCONE.

Boring operations for petroleum are now being carried on near Scone by the Thrift Syndicate. The following report on operations to date and prospects of obtaining commercial supplies of oil has been furnished by Mr. M. Morrison, Geological Surveyor.

"On the western side of Kingdon Ponds Creek, near Parkville, boring for oil has been carried out by the Thrift Mineral Prospecting Syndicate. It is understood that the first bore had to be abandoned after reaching a depth of 50 ft., and the second bore, close by No. 1, was sunk 170 ft. before being given up on account of inability to secure the necessary 4 in. casing. A third bore, situated about 400 yards distant from No. 2 bore, has been put

Digitized by Google

down to a depth of 650 ft. Operations, however, have been suspended since February last owing, it is stated, to the boring tool having become jammed in the hole. The bores were started in a deposit of alluvial, which occurs as a thin capping on the underlying Upper Coal Measures. The thickness of the Coal Measures in the locality is not known, and the particulars of the strata penetrated by the bores, as furnished by the secretary of the syndicate, are of no assistance in determining the point. It is, therefore, not known whether the 650 ft. bore has yet passed through the measures. As far as can be ascertained, no definite indications of petroleum are known to occur in the locality, and under such circumstances boring can only be regarded as stabbing in the dark. The bores have been started practically in the Upper Coal Measures, and, as previously pointed out, the prospects of obtaining commercial supplies of petroleum in these beds are not promising."

As regards the supposed occurrence of a clear, transparent oil in the waters of Kingdon Ponds Creek, and near Wingen in a dam, Mr. Geological Surveyor Morrison expressed the opinion that the phenomena are probably due to different currents in the stream, and that the indications are not such as to warrant the belief that oil occurs in the locality.

7. Yerrinbool, near Mittagong.

Boring operations are being carried on for Mr. A. J. McDonald at Yerrinbool, near Mittagong, for oil, and also to test the quality and thickness of the coal seams known to underlie this area.

No indications of the existence of oil are known to occur in this neighbourhood. The bore, commenced in Hawkesbury sandstone, will penetrate Narrabeen beds and Coal Measures, as was done at the Penrith bore. The possibilities of encountering commercial supplies of oil within such strata are exceedingly slight, and have already been discussed in connection with the Penrith bore (see pp. 32–33).

8. Other Localities.

Reported "oil-finds" at Tuncurry, Dungog, Mount Wingen, Katoomba, Airly, Capertee, Little Forest, near Milton, and many other localities, investigated by officers of the Mines Department, were found to be entirely baseless. In no case was there any real evidence of the existence of oil.

Digitized by Google

CHAPTER VII.

POSSIBILITIES OF OBTAINING PETROLEUM IN NEW SOUTH WALES.

The probabilities of obtaining petroleum in New South Wales were discussed by Mr. J. E. Carne, late Government Geologist, in his report on the Kerosene Shale deposits of the State,* in which he states :—

"The absence of any of the usual superficial indications of petroleum, such as oily exudations, or impregnations of its more or less solid residues in the form of maltha or asphaltum, is not a hopeful augury for this State, for it is doubtful whether any oil-fields have ever been developed without one or all of these constant surface adjuncts to encourage and promote research.

"True, the first great oil strike at Oil Creek, in America, was accidental, or more correctly, unexpected; nevertheless exuding oil had long been known to the European inhabitants, and the Indian tribes before them . .

". . . . The absence of any recognisable evidence of oil-bearing strata in the Palæozoic systems of New South Wales leads to speculation as to the probability of such occurring in the deeply-covered Mesozoic basins in the west-north-west, in areas as yet unpierced by artesian water bores, as to some extent indicated by the strong pressure of gas struck in the Roma No. 2 Bore (Queensland). Unfortunately here, again, probability is discounted by the absence of certain physical conditions which have been proved to govern the occurrence of oil and natural gas in America and elsewhere.

"Dome-shaped anticlinal arches of strata, resulting from lateral regional compression, form the most favourable receptacles for accumulation of these important hydrocarbon compounds in the order of their gravities. Under the roof of the dome, gas; lower down, oil; lower still, water, which subjects the former to high pressure. So far as the author is aware, with the solitary exception of the Lapstone Hill and Kurrajong Monocline, the Mesozoic strata of this State has not been subjected to even moderate folding stress, but occupy, undisturbed, their original more or less horizontal or gently-inclined position."

The fact is well established that commercial supplies of oil are only to be found in sedimentary rocks. Metamorphosed and igneous rocks are—except in exceedingly rare instances—negligible as possible sources of supply.

---

* Geol. Mem. No. 3, Kerosene Shale Deposits, Geol. Sur., N.S.W., 1903, pp. 105, 106.

Digitized by Google

The order of succession and approximate maximum thickness of the sedimentary formations of New South Wales are as under :—

			Thickness. feet.
Cainozoic.	Post-Tertiary	Recent—Alluvial deposits	up to 250
		Pleistocene -Alluvial and Glacial deposits	,, 500
	Tertiary	Upper—Alluvial deposits under newer basalts	,, 150
		Lower—Alluvial deposits under older basalts	,, 200
		Lacustrine deposits	,, 400
		Marine strata	,, 700
Mesozoic.	Cretaceous	Desert Sandstone—Sandstone and grit	,, 300
		Rolling Downs Formation—Sandstone, grit, clay, and impure limestone	,, 1,500
	Trias-Jura	Clarence Series—Conglomerate sandstone, shale, and coal seams	,, 4,000
	Triassic	Wianamatta Stage—Shale and sandstone	,, 500
		Hawkesbury Stage—Sandstone and shale	,, 1,200
		Narrabeen Stage—Sandstone and shale	,, 1,800
Palæozoic.	Permo-Carboniferous	Upper Coal Measures	,, 1,500
		Dempsey Series	,, 2,200
		Middle Coal Measures	,, 1,800
		Upper Marines	,, 6,400
		Lower Coal Measures	,, 300
		Lower Marines	,, 4,800
		(Conglomerate, sandstone, shale, and coal seams.)	
	Carboniferous	Conglomerate, sandstone, quartzite, limestone, shale, claystone, tuff	,, 20,000
	Devonian	,, ,, ,, ,,	,, 30,000
	Silurian	,, ,, ,, ,,	,, 5,000
	Ordovician	,, ,, ,, ,,	,, 9,000
	Cambrian	Limestone, glacial beds, tillite, and slate	,, 10,000
	Pre-Cambrian	Highly metamorphosed sandstones and shale.	(?)

Diagrammatic sections across New South Wales, from E. to W. and from N. to S., on page 42, illustrate the general relationships of these formations :—

1. *Post-Tertiary.*—The Post-Tertiary beds consist of Recent and Pleistocene alluvial deposits—sands, gravels, and clays—occurring along present streams, and marking the courses of ancient rivers.

These sediments reach their maximum development in the western portion of the State, where the flood plains of neighbouring rivers have junctioned. They may range up to 500 feet in thickness, and cover a considerable area of territory.

Such sediments in New South Wales have not been subjected to the necessary conditions of heat and pressure to convert any organic material they may contain into hydrocarbon compounds, and consequently can be disregarded as a possible source of oil supply.

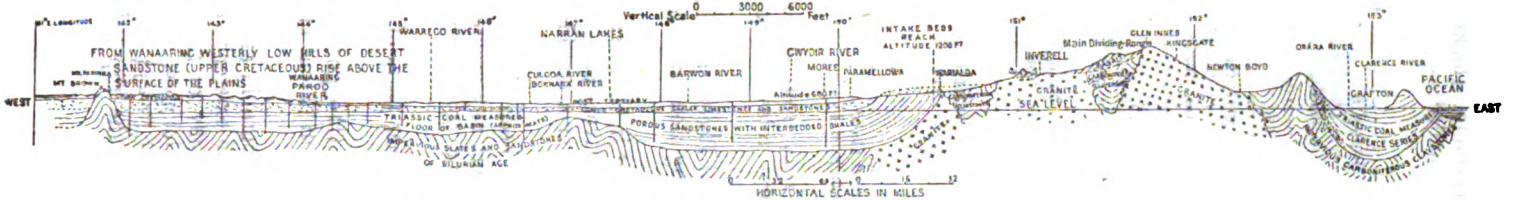
2. *Tertiary.*—Tertiary rocks, so prolific in oil in other parts of the world, are but little developed in New South Wales.

The several deep lead alluvial deposits occurring throughout the State were formed during this period, but these are limited in extent and offer no prospects of yielding oil.

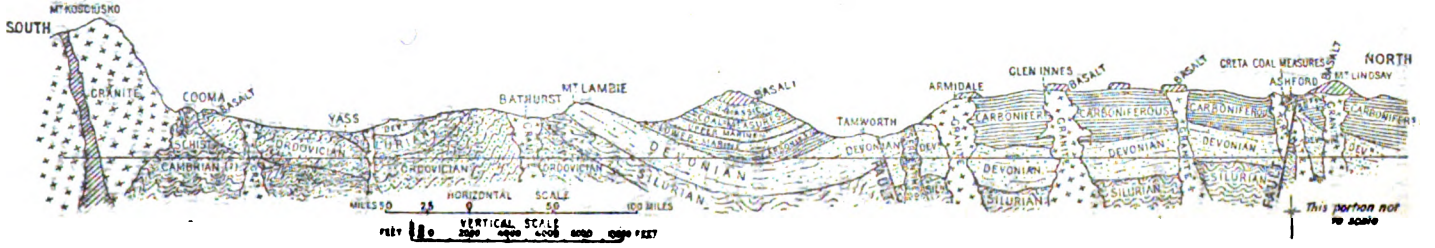
Recent borings for coal in the neighbourhood of Coorabin and Oaklands, in the southern portion of the State, have proved the existence of a fairly extensive series of lacustrine deposits, consisting chiefly of sands, gravels, clays, and sub-bituminous coal, totalling 350 feet in thickness. The outcrop of these beds is masked by a covering of Pleistocene and Recent clay and soil, but the borings prove the series to be gently tilted, the dip being south-westerly at the rate of 130 feet per mile.

Digitized by Google

Diagrammatic Section from East to West across New South Wales (*E. F. Pittman*).

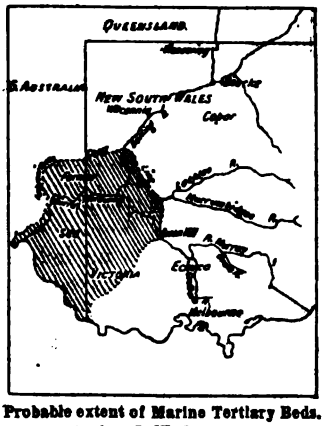


Diagrammatic Section from North to South across New South Wales. (*After Prof. T. W. E. David*).



Digitized by Google

Marine sediments, for the most part concealed by more recent superficial deposits, outcrop in places along the lower courses of the Murray and Darling Rivers. It is not known exactly how far these beds extend easterly, but their probable extent is shown on the following sketch plan :—



Probable extent of Marine Tertiary Beds.
(After J. W. Gregory.)

The rocks comprising these beds consist of calcareous sandstones, clays, and shales containing marine fossils. A bore put down at Arumpo, 60 miles E.N.E. of Wentworth, proved the beds to be at least 650 feet thick.

Both the lacustrine and the marine sediments of Tertiary age in New South Wales are fairly rich in organic remains, and offer slight possibilities for the occurrence of commercial supplies of oil. It must be remembered, however, that these beds are practically flat and have been but little disturbed, consequently there has been but little opportunity for oil that may be disseminated through the rock to accumulate into commercial pools. If a favourable geological structure can be located in these beds, there would be reasonable prospects of oil being located by boring.

Cretaceous.—Cretaceous rocks consisting of marine sandstone, shale, limestone, marl, and gypseous clay, and fresh-water deposits containing plant remains and thin seams of coal, occupy an extensive area in the western portion of New South Wales. The individual beds are but little altered, and generally horizontally disposed.

Abundant organic remains are present from which, given the proper conditions, oil might be formed; and porous beds, suitable to serve as reservoir rocks, occur intercalated with impervious shales. Two of the essential conditions for the occurrence of oil are thus present, but the lack of suitable structures for concentrating the oil, if present, renders small the prospects of obtaining commercial supplies from such beds.

These Cretaceous rocks have been penetrated by several bores, sunk for artesian water, without a single trace of crude oil having been disclosed.

Trias-Jura.—The Trias-Jura sediments, which include the Clarence series and the Artesian series, are of fresh water origin and include shales, sandstones, grits, conglomerates, and coal-seams.

They outcrop on both sides of the main divide; on the east they form a well-defined basin (Clarence series) in the north-east corner of the State; and west of the divide they constitute the water-bearing beds (Artesian series) of the artesian basin.

With the exception of the coal horizons, these sediments are characterised by the paucity of organic remains, and moreover, the conditions under which they were laid down were unfavourable for the accumulation of oil.

Digitized by Google

No trace of petroleum nor its products have been found associated with th coal-beds, and as they outcrop over a considerable area of country and hav been prospected in several places, it is reasonable to assume that oil is no present.

Innumerable bores, sunk for artesian water, have penetrated these bed in the western portion of the State without disclosing a single trace of oi but in some cases gas, chiefly methane (CH_4), has been encountered.

Mr. Mingaye, Government Analyst, has made the following determina tions :—

Name of Bore.	Depth.	CO_2.	O.	CH_4	N.
Tholoo	1,700 ft.	Nil.	Nil.	50·00	50·00
Currumbah	2,816 „	4·16	Nil.	39·73	56·11
Bryanungra.....	2,370 „	Nil.	8·00	28·64	63·36
Kiga No. 2	1,857 „	Nil.	Nil.	64·33	35·67

Such gases are no indications of the occurrence of petroleum, but hav probably been derived from carbonaceous materials, several horizons o which are known to occur in these beds.

Irrespective of structure, these Trias-Jura beds can be neglected as a possibl source of oil.

Triassic.—Triassic sediments of fresh-water origin, consisting of shales sandstones, and grits, and characterised by the paucity of fossils, occupy a considerable area of country. They overlie the main Permo-Carboniferou coal-basin of the State.

There is but little, if any, prospects of ever obtaining commercial supplies of oil from the Triassic beds in this State, for not only were the con ditions of sedimentation unfavourable, but they also lack the necessary organic remains from which oil might be formed.

Permo-Carboniferous.—The Permo-Carboniferous sediments developed in New South Wales comprise both fresh-water and marine beds, and have a maximum thickness of about 17,000 feet. They are strongly developed in the eastern portion of the State, where they occur in the form of a great basin, extending from the coast to the western edge of the Blue Mountain tableland, and from the Illawarra district northwards to the southern edge of New England tableland.

The Permo-Carboniferous system in New South Wales is subdivided into the following series :—

1. Upper Coal Measures.—Fresh-water beds comprising shale, sandstone, conglomerate, and coal-seams; having a maximum thickness of 1,500 feet.
2. Dempsey Series.—Fresh-water beds comprising shale and sandstone; totalling 2,000 feet.
3. Middle Coal Measures.—Similar to Upper Coal Measures; up to 2,000 feet thick.
4. Upper Marine Series.—Marine beds comprising shale, sandstone, grit, tuff, and conglomerate, with abundant marine fossils; attaining a maximum thickness of 6,000 feet.
5. Lower Coal Measures.—Fresh-water beds comprising shale, sandstone, conglomerate, and coal seams; aggregating 300 feet.
6. Lower Marine Series.—Similar to upper marine beds, and totalling 4,800 feet in thickness; abundant marine fossils.

Digitized by Google

A good deal of prospecting work has been carried out in New South Wales n each of the Upper, Middle, and Lower Coal Measures without disclosing a ingle indication of crude oil. Kerosene shale or oil shale has been found in oth the Upper and Lower Coal Measures, but as previously pointed out, this s no indication of the occurrence of crude oil. Though small seepages of etroleum have been found associated with coal, as in England and France, n no instance has commercial supplies of crude oil been derived from alæozoic coal-beds.

The Dempsey series, of fresh water origin and containing but few fossils ffers no prospects of yielding oil.

Both the Upper and Lower Marine Series are characterised by abundant rganic remains, and as they include porous beds that would serve as reservoirs or oil, they at least possess some of the essentials for the occurrence of oil. n view, however, of the absence of any indication of petroleum or its products ver the wide areas occupied by the outcrops of these beds, the possibilities f their being oil-bearing is not very promising.

Neither the Upper or Lower Marine sediments are highly folded, but they ave in places been considerably disturbed by faulting, which might have ermitted the escape of any oil and gas the beds may have contained. uitable structures for the accumulation of oil could doubtless be found in hese beds if searched for, and though boring would not be justified until t could be shown that the rocks were oil-bearing, the possibilities of striking il would be ever so much greater than boring through our Triassic rocks, as s being done at present.

Carboniferous.—A considerable area of the coastal plain and tableland orth of Newcastle is occupied by rocks of Carboniferous age. These comprise uffaceous sandstone, claystone, limestone, conglomerate, cherty shale, with contemporaneous lava and tuff. These beds are partly marine and partly fresh-water in origin, and have been estimated to be 19,000 feet thick. Abundant organic remains are present in some of the beds, and porous strata to act as reservoirs occur intercalaced with impervious strata. The beds are for the most part gently folded, and anticlines and synclines are of frequent occurrence.

Most of the conditions required for the occurrence of oil can be found amongst the Carboniferous strata, but so far no trace of oil in these beds has been recorded.

The absence of oil may possibly be accounted for by the fact that the beds have undergone considerable disturbance, have been fractured and faulted as a result of earth movements, and metamorphosed by extensive granite intrusions, factors that would tend to dissipate any oil or gas that the beds might contain.

Devonian, Silurian, and Ordovician.—The possibilities of the occurrence of commercial supplies of oil and gas in Devonian, Silurian, and Ordovician sediments can be conveniently discussed together.

They each contain, on certain horizons, abundant organic remains necessary for the formation of oil; they possess the requisite porous beds, with adequate cover of impervious strata; and, finally, ideal geological structures exist for the accumulation of oil and gas.

Digitized by Google

Such conditions are to be found among:—

Devonian sediments at—Rylstone, Carlos Gap, Goodradigbee, &c.
Silurian sediments at—Yass, Taemas, Quidong, Queanbeyan, &c.
Ordovician sediments at—Tolwong, Caloola, Manduramma, &c.

Careful search at each of the above localities has failed to reveal a single trace or surface indication of the occurrence of either oil or gas.

While petroleum may yet be found in New South Wales in rocks of these ages, it is more likely that any oil or gas that the beds may have contained originally has been lost as a result of the disturbance—folding, fracturing, and faulting—and alterations that the rocks have undergone since deposition.

The only Palæozoic strata in the world known to yield commercial supplies of oil occurs in North America, where the old sediments have undergone but little alteration and been hardly disturbed by earth movements, the beds showing a general dip of only from 1 to 10 feet per mile.

We have no Palæozoic rocks in New South Wales so little altered and undisturbed as the North American oil-bearing Palæozoic rocks.

Cambrian and Pre-Cambrian.—The intense alteration that the sediments belonging to these periods have undergone since deposition precludes all possibility of oil or gas being found amongst them.

SUMMARY.

The prospects of obtaining commercial supplies of oil in New South Wales are by no means bright. There are possibilities of oil being obtained from the Tertiary marine rocks in the vicinity of the lower Murray, or from the fresh-water deposits near Coorabin, if suitable geological structures can be located. The Mesozoic rocks, owing either to the paucity of organic remains and unfavourable conditions of sedimentation, or lack of suitable geological structures, may be disregarded as possible sources of oil. The evidence from the numerous bores sunk through these beds for artesian water and in prospecting the underlying Coal Measures supports this contention.

Of the Palæozoic rocks, the Coal Measures offer no prospects of obtaining supplies, but both the Upper Marine and Lower Marine beds may yet prove to contain oil.

Rocks older than Permo-Carboniferous, though possessing most of the qualifications required for the occurrence of oil, have as a result of the structural changes and alteration that they have undergone, probably lost any oil or gas that they may originally have contained.

It would thus appear as if New South Wales will have to depend for its oil supplies, not upon deposits of crude petroleum, but upon the mining and distillation of oil-shales, extensive deposits of which are known to occur within the State, and have been exhaustively dealt with by Mr. Carne in his report on the Kerosene Shale deposits of New South Wales.*

* Geol. Memoir No. 3, Geol. Survey, N.S.Wales, 1903.

Digitized by Google

APPENDIX I.

Mining Regulations Regarding the Prospecting for Oil in New South Wales.

The Regulations under the Mining Act of New South Wales have recently been amended and increased the extent of a "Mineral Prospecting Area" to search for "mineral oils, petroleum, or natural gas" from 40 acres to 640 acres. Leases of Crown Lands may be acquired in areas of 640 acres each. Authority to prospect on Crown Lands may be obtained of such area and under such conditions as the Minister may fix.

An Extended Area of Private Lands to prospect or mine for mineral oils, petroleum, or natural gas may be granted for such area as the Minister, on the recommendation of the Warden and Prospecting Board, may direct.

APPENDIX II.

Federal and State notifications of Rewards offered for the Discovery of Commercial Quantities of Oil.

[*Extract from Commonwealth of Australia Gazette, No.* 1, *dated 2nd January*, 1920.]

Prime Minister's Department,
2nd January, 1920.

REWARD BY THE COMMONWEALTH GOVERNMENT FOR THE DISCOVERY OF PETROLEUM OIL IN COMMERCIAL QUANTITIES IN AUSTRALIA.

A REWARD of £10,000[1] will be paid by the Commonwealth Government for the discovery of petroleum oil in commercial quantities in Australia, subject to the following conditions:—

(1) Any person* who is engaged in boring for oil in Australia, and who desires to be considered as a possible claimant for the reward shall—

(*a*) within two months after this date, if he has already begun boring,

(*b*) within two weeks from the date of his commencing boring,

* The word "person" includes person, firm, or company.

notify the Minister for Home and Territories in writing at his office in Melbourne. He shall at the same time furnish the following information:—

Precise locality of bore;

If any work done, a full statement relating thereto, including complete and technically correct daily records of strata passed through, sizes of casing and lengths of each size, particulars with regard to the striking of water, fresh, salt, or otherwise, mineralized, hot springs, showings of gas and oil.

(2) He shall, at intervals of not less than one month from the date of above notification, send to the Minister for Home and Territories, and to the Minister for Mines in the State in which he is boring, a full report of all work done on or in connection with the bore since last report.

(3) The Minister for Home and Territories, and the Minister for Mines for the State, or either of them, may authorize any officer to visit the bore, inspect all operations and records, examine all material extracted from the bore hole, satisfy himself that proper steps are being taken to insure maximum production and to prevent flooding by water of possible oil-bearing strata, examine storage tanks, take test samples at various depths, and make tests with standard apparatus to ascertain the quantity of water present.

Every facility shall be afforded by the claimant and his employees to such officer to make such investigations as he may deem fit.

---

[1] This amount has since been increased to £50,000, vide *Commonwealth of Australia Gazette*, 23 September, 1920.

Digitized by Google

(4) Should any oil-bearing strata be passed through in the course of boring operations, samples of the oil shall be taken, and not less than 2 gallons, free from water and other removable impurities, shall be sent to the Minister for Home and Territories and the Minister for Mines, in sealed receptacles, with properly authenticated certificates as to the manner in which the oil was obtained.

(5) No payment of the reward shall be authorized unless it is proved to the satisfaction of the Minister that oil to the extent of 50,000 gallons has been obtained, and that the bore is still flowing freely and producing oil in commercial quantities.

(6) If any dispute arises—

(*a*) as to who is entitled to the reward; or

(*b*) as to the manner in which the reward is to be distributed in cases where there are more claimants than one; or

(*c*) whether the conditions to be fulfilled in order to entitle the claimant to the reward have been fulfilled; or

(*d*) in any way concerning the claim to be a *bonâ fide* discoverer of oil in commercial quantities or for reward;

the Minister for Home and Territories may determine the dispute, and his decision shall be final and conclusive.

W. M. HUGHES, Prime Minister.

[*Published in Government Gazette No.* 180 *of 8th October*, 1920.]

[2584]

Department of Mines,
Sydney, 6th October, 1920.

REWARD FOR THE PRODUCTION OF PETROLEUM (NATURAL MINERAL OIL) WITHIN THE STATE OF NEW SOUTH WALES.

NOTICE is hereby given that a reward of Ten Thousand Pounds (£10,000) will be paid to the person or Company who shall first produce One Hundred Thousand (100,000) gallons of Petroleum (Natural Mineral Oil) within the State of New South Wales, and report same to the Minister.

The claimant for the reward must satisfy the Minister for Mines, or an officer appointed by him, that the quantity stipulated has been produced and obtained exclusively within the State of New South Wales, and must support the claim by duly attested books and vouchers properly kept for that purpose.

The Minister shall be the sole judge as to any matter in dispute in regard to an application for reward or the payment thereof.

[Papers 1920–4,953–241 P.B.]

GEORGE CANN,
Secretary for Mines.

Sydney: William Applegate Gullick, Government Printer—1921.

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, Government Geologist.

MINERAL RESOURCES

No. 32.

The Coal Resources of the Douglas Park Area,

and

Tabulated List of Coal Bores, Counties of Cumberland and Camden.

BY

L. F. HARPER, F.G.S.,

Senior Geological Surveyor.

Issued under the Direction of the Hon. J. C. L. Fitzpatrick, Minister for Mines.

SYDNEY: ALFRED JAMES KENT, GOVERNMENT PRINTER.

1924.

† 25947—A [1s]

Digitized by Google

Science Library
TN
122
.N421
A3
no. 32

Digitized by Google

The Coal Resources of the Douglas Park Area, with Map, Sections, and Tabulated List of Coal Bores and Table of References, Counties of Cumberland and Camden.

The area dealt with is situated on both sides of the main Southern railway line between Campbelltown and Bargo, as shown on the accompanying plan.

Prior to 1914, prospecting for coal by diamond drill had been carried out at Moorebank (near Liverpool), Hill Top, Colo Vale, Mittagong, and Bundanoon. A coal seam had also been opened up at Mittagong, Berrima, Bundanoon, Emu Swamp, and Exeter, but results were not satisfactory, and all the evidence points to the Bulli coal seam having thinned out entirely south of Colo Vale, whilst the information gained from the Moorebank Bore is capable of more than one interpretation.

This bore has an important bearing upon the possible extension of the Bulli Seam as a commercial undertaking north from Campbelltown. The bore was put down during 1889–90, and the following information is available* :—

Surface 40 feet above sea level.

No record available as to the position of the Chocolate Shale horizon.

Top coal seam at 2,493 ft. 6 in. from surface.

	ft.	in.
Coal	1	5
Sandstone and shale	12	8¼
Second coal seam, coal	1	4
Dark sandstone and shale with fine conglomerate... ...	75	10¾
Third coal seam, coal	6	6½
Total depth of bore	2,601	6

The following analysis of a sample from the core recovered from the third seam was made in the Departmental Laboratory† :—

	Per cent.
Hygroscopic moisture	·85
Volatile hydrocarbon	19·40
Fixed carbon	67·40
Ash	12·35
	100·00

Coke.—79·75.

Sulphur.—·44.

Specific gravity.—1·410; ash grey; coke well swollen up, lustrous, and firm.

---

* Ann. Rept. Dept. Mines N.S. Wales, for 1890, pp. 138, 149.

† Ann. Rept. Dept. Mines for 1891, p. 245.

Digitized by Google

It was considered at the time that the third seam penetrated was referable to the Bulli Seam, but in 1915 the possibility of the three seams penetrated representing No. 1 or Bulli, No. 2 The Four Feet, and No. 3 or the Thick Seam of the Illawarra Coal-field was entertained by the Writer. Should this be correct, it points to a thinning of the Bulli Seam in the direction of Liverpool, but there is no evidence available as to how far north of Menangle this possible thinning is likely to effect the seam from a commercial standpoint.

In 1914 the Appin Bore was put down in the position shown on the accompanying map, and the following information was obtained* :—

Surface 617 feet above sea level.

	ft.	in.
Wianamatta Shales to	44	0
Hawkesbury Stage to	642	0
Top of Chocolate Shale horizon, here 78 ft. thick	642	0
Narrabeen Stage to	1,614	9
Top of Bulli Coal Seam	1,614	9
Clean coal	8	3
Top of No. 2 or the "Four Feet Seam"	1,647	5
Coal	3	4
Top of No. 3 or the "Thick Seam"	1,695	0
Coal and bands	687	8
Top of No. 4 Seam	1,940	0
Splinty coal	4	4
Total depth of bore	2,295	0

An average sample of the core from No. 1 or the Bulli Seam gave the following result on analysis in the Departmental Laboratory :—

	Per cent.	
Hygroscopic moisture	0·48	
Volatile matter	21·43	
Fixed carbon	67·67	Coke, 78·09.
Ash	10·43	
	100·01	

Coke.—Fairly swollen, firm, dull lustre.
Ash.—Grey in colour, semi-granular.
Sulphur.—0·178. Specific gravity.—1·378.
Calories.—6,766. B.T.U.—12,184.
One pound of this coal will convert 12·6 lb. of water into steam.

The results obtained by this bore were most encouraging, as indicating the western extension of the high-grade coal of the Southern or Illawarra Field.

* Geology No. 7, Geol. and Min. Resources S. Coalfield, p. 401.

Digitized by Google

In February, 1917, the Writer suggested the desirability of reserving from mining lease a belt of country within the Picton-Bargo area with a view to the possibility of opening up a State Coal-mine on the main Southern Railway Line. A Reservation was made, and in 1920 the Bargo Bore was commenced. (*See* map.)

The bore was completed in 1921, and the following section shows the information available* :—

Surface—approximately 825 feet above sea level (just below base of Wianamatta Stage).

	ft.	in.
Hawkesbury Stage to	502	0
Top of Chocolate Shale here 59 feet thick	502	0
Narrabeen Stage to	1,279	0
Top of Bulli Seam	1,279	0
Clean coal	5	0
Top of No. 2 or the "Four Feet Seam"	1,312	0
Coal	1	6
Top of No. 3 or the "Thick Seam"	1,392	0
Carbonaceous shale with coal bands.	18	0
Bottom total depth of bore	1,410	0

An average sample of the core from No. 1, or the Bulli Seam, was analysed with the following result :—

	Per cent.
Hygroscopic moisture	1·00
Volatile matter	29·05
Fixed carbon	61·93
Ash	8·02

Sulphur.—0·287

Specific gravity.—1·358.

Calories.—7,142. B.T.U.—12,867. Coke.—69·95.

One pound of this coal will convert 13·3 lb. of water into steam.

The results obtained by this bore, taken in conjunction with the information furnished by the Appin Bore and the coal analyses, have established the fact that a good workable seam of coal exists over a considerable area.

That the Bulli Seam thinned out to the south had been proved by the Hill Top and Mittagong bores, whilst the Moorebank Bore indicated a similar possibility some distance to the north.

Authorities to Enter and search for coal were granted in 1921 over a large area extending from Douglas Park to near Menangle.

* Ann. Rept. Dept. Mines for 1921, p. 42.

Digitized by Google

The first bore reached the No. 1 or Bulli Seam on the 14th of December, 1922, and the information obtained is as follows :—

Douglas Park Bore, situated about half a mile north of Douglas Park Railway Station, on left bank of Harris Creek, within Portion 6, Parish Camden, County Camden.

Surface—Approximately 390 feet above sea level (base of Wianamatta Stage).

		ft.	in.
Hawkesbury Stage to 666 feet.			
Top of Chocolate Shale horizon, here 77 feet 6 inches thick	Narrabeen Stage.	666	0
At 1,552 feet, 9 feet Cupriferous Tuffs	Narrabeen Stage.		
From 1,603 feet to top of Bulli Seam numerous nodules of carbonate of iron	Narrabeen Stage.	ft. 1,687	in. 9½
Top of Bulli Seam		1,687	9½
Coal		8	10½
Top of No. 2 or the "Four Feet" Seam		1,728	8
Coal		1	4
Floor, fire-clay.			
Bottom of bore		1,730	0

An average sample of the core from No. 1, or the Bulli Seam, was analysed with the following result :—

	Per cent.
Hygroscopic moisture	0·64
Volatile matter	25·05
Fixed carbon	65·92
Ash	8·39
	100·00

Sulphur.—0.227. Specific gravity.—1·350.
Coke.—74·31 per cent. Calories.—7,088. B.T.U.—12,764.
One pound of this coal will convert 13·2 lb. of water into steam.

In January, 1923, the boring a second bore was commenced at a site about 2 miles S.S.W. of Menangle and 1¾ miles a little E. of N. of the Douglas Park Bore.

Menangle Bore.—Within Subdivision 19, Portion 5, Parish Camden, County Camden.

Surface—Approximately 325 feet above sea level.
Wianamatta Stage to 60 feet.
Hawkesbury Stage to 715 feet.

		ft.	in.
Top of Chocolate Shale horizon, here 90 feet thick	Narrabeen Stage.	725	0
Cupriferous Tuffs not identified	Narrabeen Stage.		
Carbonate of iron nodules plentiful	Narrabeen Stage.	ft.	in.
Top of Bulli Seam		1,794	6
Roof, very carbonaceous shale		0	2
Clean coal		8	9
Top of No. 2 or the "Four Feet" Seam		1,838	0
Stony coal		1	3
Band		0	0¼
Coal and bands		1	7
Band		0	2
Floor, fire-clay		2	0
Bottom of bore		1,843	0¼

An average sample of the core from No. 1, or the Bulli seam, was taken by the Writer, and the method adopted of sampling is worthy of recording (*see* Appendix A).

Digitized by Google

The sample, taken in the manner described, was analysed in the Departmental Laboratory with the following result :—

	Per cent.	
Hygroscopic moisture	0·45	
Volatile matter	25·45	
Fixed carbon	66·12	Coke, 74·10 per cent.
Ash	7·98	
	100·00	

Sulphur.—0·329. Specific gravity.—1·362.
Calories.—7,088. B.T.U.—12,764.
One pound of this coal will convert 13·2 lb. of water into steam.
Coke —Well swollen, firm, dull lustre.
Ash.—Grey, granular.

From the foregoing it is apparent that an area of not less than 14,000 acres has been prospected by four bores, for the most part widely separated, and the results have been very satisfactory. The identification of the top seam with the Bulli seam of the Southern Coal-field is thus indicated. The excellence of this coal for steaming and coke production is well known.

During the years 1917 to 1920, a private bore was sunk near Penrith. As this bore has a bearing upon the extension of the coal seams in a north-westerly direction, the information available in the Department is given here. The bore was not put down under Government supervision, and no official record of strata penetrated is available, but the following particulars are probably fairly correct.

The position of the bore is shown on the map herewith, and is close to Mulgoa Creek, in Portion 39, Parish Mulgoa, County Cumberland.

Surface, 175 feet above sea level.
Wianamatta shales to 50 feet.
Hawkesbury stage, to 1,000 feet.
Narrabeen stage to 2,523 feet.
(Cupriferous tuffs at 1,500 feet.)*
Top coal seam at 2,523 feet.
Coal, 14 feet.
Bottom of bore, 2,700 feet.

No section of the seam is available, and no sample of the coal was submitted for analysis in the Department, so that it is not possible to express a definite opinion as to the identity of the seam, but the Bulli seam has no bands over the area as worked, with one exception of local extent only, throughout the area worked.

The exception is recorded by Mr. Pittman as occurring in the Metropolitan Colliery workings,* but it must be remembered that conditions there are apparently not normal, for in addition to the coal won from the headings specified and those adjacent being non-coking, an exceptional thickness is proved in the seam, *i.e.*, about 11 feet, with 6 feet and over of clean coal at the top, but two bands 1 inch thick in the lower portion.

About 12 miles distant, in a direction a little west of south of this bore, the top coal seam is to be seen outcropping in the banks of the Warragamba River, at an altitude of about 200 feet above sea level, and is dipping in a northerly direction at an angle of about 2 degrees. This seam consists of about 12 feet of coal and bands, and is quite unlike any outcrop of No. 1 or the Bulli Seam.

* The Coal Resources of N.S. Wales, 1912, p. 89.

Digitized by Google

About 4 miles higher up-stream, on the left bank of the river, the top seam has been opened up by a short tunnel, and the following section exposed :—

Roof, shale.

	ft.	in.
Splinty coal	0	3
Bituminous coal	1	6
Splinty coal	1	8

Floor, very carbonaceous shale.

About one mile further up stream, on the same bank, an outcrop of coal is to be seen near the base of the Measures, and about 400 feet below the tunnel referred to. This probably represents the Lithgow Seam.

About eight miles south of the outcrop referred to above, on the east side of the Wollondilly River, and near the Nattai Post Office (Riley's) exposures of a coal seam are to be seen about 650 feet above the river level.

The following section of the most northerly outcrop measured in 1914, and published in the Annual Report for that year :—

Roof, sandstone and shale.

	ft.	in.
Bituminous coal	4	2
Clay band	0	1
Coal (splinty in part)	1	9
	6	0

Below this exposure the following section was obtained :—

	ft.	in.
Shales	25	0
Blue shale with coal bands at top	6	0
Sandstone	1	3
Shales with coal bands	9	0
Light and dark grey shales	100	0
Sandstone	6	0
Grey shales	.....	

About three-quarters of a mile further south, under the same mountain range, another good exposure of this seam is to be seen, and the following section was measured :—

	ft.	in.
Shale and sandstone	90	0
Clean coal	5	6
Mainly shale, including two thin bands of coal	25	0

A sample of coal from this exposure, obtained by Mr. J. B. Jaquet, Chief Inspector of Mines, was analysed in the Departmental Laboratory with the following result :—

	Per cent.
Hygroscopic moisture	2·40
Volatile hydrocarbons	26·97
Fixed carbon	58·74
Ash	11·89
	100·00

Sulphur.—·357.
Specific gravity.—1·345.
Calorific value.—11·8.
Ash.—Grey in colour, semi-granular.
Coke.—Fairly swollen, firm, lustrous.

The same seam has recently been exposed in a cut on the left-hand side of the road as descending, about a quarter of a mile above the Nattai Post Office. Here about 5 feet of coal with numerous clay partings has been

Digitized by Google

exposed, but the cut is not in far enough to warrant obtaining a sample for analysis. From appearances, if it should be the Bulli Seam; it has here very much deteriorated and altered in appearance.

During an examination of the country south and east from the above exposures, in 1922, no evidence of the Bulli Seam occurring in the country bounded by the Nattai River, the Little River and Blue Gum Creek, was found. In my opinion that seam has thinned out entirely in this area, for the typical Coal Measure fossil *Glossopteris* occurs at least 50 feet above the top indications of coal, and none of the exposures give much promise of being workable.

The foregoing information regarding the known occurrences of coal in the western portion of the area included in the accompanying map is supplied in order to assist in arriving at a basis upon which to form an opinion as to what area of workable coal is likely to exist. Volcanic influences are an important factor to be considered in connection with a coalfield, but evidences of such are not numerous within the area under review. The evidence available from bores points to the absence of extensive destruction of coal seams by volcanic agencies, for the Douglas Park Bore is little over two-thirds of a mile from several dykes exposed in a railway cutting north of Douglas Park Railway Station, but the core disclosed no evidence of the seams penetrated having been affected by volcanic agencies.

The Menangle Bore is situated if anything closer to a small volcanic neck, but here again the coal has been in no way affected.

In the light of present evidence it appears more than likely that an area of approximately 160 square miles of workable coal occurs between Bargo on the south, and Campbelltown on the north, extending in an east and west direction from Appin to Picton.

Allowing 1,200 tons of recoverable coal per acre foot, and an average thickness of 6 feet of coal, this area is likely to contain over 730 million tons of coal.

It is generally agreed that estimates of coal reserves may be made on a less conservative basis than are those of deposits such as gold, silver, lead and copper; nevertheless, to conform to the general rules laid down for the estimate of ore reserves, it is considered that a safe estimate of coal reserves within the area proved by the Appin, Menangle and Bargo Bores may be allowed on the following basis.

The area tested by the bores forms a right-angled triangle with a perpendicular 9 miles long, and a base of 5 miles, within which, by boring, has been proved to exceed 8 feet in thickness at three points.

Assuming, however, that a thickness of only 6 feet occurs over the whole area, 14,000 acres approximately, and that 1,200 tons of coal are recoverable per acre foot, then the coal reserves within the triangle actually proved by boring is likely to exceed 100,000,000 tons. In all probability the workable coal extends for some miles in each direction beyond this area prospected by the bores, and the tonnage to be expected may exceed 250,000,000.

The importance of this area as regards the coal resources of the State cannot be over estimated, and the prospecting work to date should add very many millions to our mineral resources.

There appears no reason why an important coalfield should not be developed within 40 miles of Sydney, and in addition to export possibilities, the winning of coal in this area promises cheaper coal for the whole of the Southern Railway System, and favourable conditions for the extension of manufacturing interests beyond the confines of the metropolitan area, and yet convenient to it.

Digitized by Google

APPENDIX.

To obtain an average sample of a coal core one or other of the following methods may be adopted :—

(1) Break up the whole core and quarter it down until sufficient is obtained for the analyst.

The disadvantage of this method is that the whole of the core is broken up into small fragments, and in this state subsequent examination of stratification and the physical properties of the seam as a whole are impossible.

(2) (*a*) Other methods are to chisel out a groove down the full length; (*b*) cut the core right in half longitudinally; (*c*) after splitting the core into convenient lengths, to break off a portion of each segment, and thus obtain a sample.

It is difficult to chisel out a fair sample, as the more friable and bright portions of the core come away easily, and are likely to form a percentage of the samples in excess of their due proportion of the core.

Appliances for cutting the core in half longitudinally are not available as a rule, and to cut with an ordinary hand-saw is difficult and slow.

In breaking off a portion of each segment with a hammer it is also difficult to avoid obtaining an undue proportion of the friable coal, or from breaking the core so that subsequent examination is unsatisfactory.

A coal core almost invariably breaks into segments from a few inches up to 2 or even 3 feet in length.

If a hack saw be used, and two cuts an inch apart be made down each segment of the core, forming a V with a depth of $\frac{3}{4}$ of an inch, it is easy to secure an average sample and yet leave the core practically intact for subsequent examination.

TABULATED LIST OF BORES IN THE COUNTIES OF CUMBERLAND AND CAMDEN.

With Index to previous reference.

Information regarding the various bores put down in New South Wales in search of coal is contained in the Departmental Reports. In the case of many of the earlier bores, the exact locality and surface altitude was not given, nor has any attempt been made in the past to correlate the evidence yielded by the bores.

In order to put the information in a convenient form for reference, and, where possible, obtain the exact locality, Mr. A. A. Atkinson, Chief Inspector of Coal Mines, prepared a list of bores, giving detailed sections of strata penetrated, with exact localities and altitudes, when obtainable.

The information thus compiled is tabulated, together with brief geological notes.

Digitized by Google

Bores in the Counties of Camden and Cumberland—Permo-Carboniferous Basin.

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam	Depth to top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
1	Bundanoon, No. 1 Bore, portion 1, parish of Bundanoon, county of Camden, east of road.	1886	2,100 0	.....	.....	.....	.....	Surface	347 1	...	147 1	1 ft. 2 in. coal.
								Total depth = 720 ft. 3 in.				
2	Bundanoon, No. 2 Bore, portion 1, parish of Bundanoon, county of Camden, between railway and road.	1886	2,100 0	.....	.....	.....	.....	Surface	238 7½	...	231 4	5 ft. 9 in. coal and bands.
								Total depth = 380 ft. 1 in.				
3	Joadja, No. 1 Bore, north-west corner portion 122 (M.L. 27, J. E. Carne), parish of Joadja, county of Camden.	1888	2,540 0	Surface	258 7	.....	.....	258 7	382 0	...	258 7	38 ft. 3 in. coal and bands.
												Three thin seams follow.
4	Joadja, No. 3 Bore, near south-east corner portion 69, parish of Joadja, county of Camden.	1889	2,540 0	,, ...	142 8	.....	.....	142 8	256 7	...	142 8	43 ft. 5 in. coal and bands.
											218 7	3 ft. 6 in.
											251 7	1 ft. 6 in.
5	Joadja, No. 4 Bore, north-east corner portion 71, parish of Joadja, county of Camden.	1889	2,540 0	,, ...	381 9	.....	.....	381 9	490 11	...	381 9	38 ft. 2 in. coal and bands.
											450 7	3 ft. 4 in. coal and band.
6	Joadja, No. 2 Bore, north-east corner portion 69, parish of Joadja, county of Camden.	1888	2,540 0	,, ...	333 1	.....	.....	333 1	365 1	...	333 1	30 ft. coal and bands.
6a	Shale, Petrol Oil Co.'s Bore, ¼ mile north-east of north-east corner portion 163, parish of Joadja, county of Camden.	1922	.....	.....	.....	.....	.....	.....	...	...	...	.....
7	Joadja, No. 5 Bore on Joadja Creek. (Exact locality unknown.)	1889–1890	.....	,, ...	195 5	.....	.....	195 5	357 2	...	095 5	46 ft. coal and bands.
											338 11	15 ft. 9 in. coal and bands.
7a	Two bores put down in beds of marine age. Portion 43, parish of Joadja, county of Camden. (For position, see map)—											
	(a)	.....	.....	.....	.....	.....	.....	Surface	126 0	...	.....	.....
	(b)	.....	.....	.....	.....	.....	.....	,, ...	110 0	...	.....	.....
8	No. 1 Bore, Colo Vale, portion 51, parish of Colo, county of Camden. (By No. A drill.)	1884	2,000 0	Surface	345 0	.....	Bore abandoned.		.....	...	.....	.....
9	No. 2 Bore, Colo Vale, portion 51, parish of Colo. (By No. 3 drill.)	1884–1885	2,000 0	,, ...	.....	Not determined.		656 4	1,110 0	1 or 2	656 4	8 in. Coal.
										3	729 10	2 in. coal.

Digitized by Google

Bores in the Counties of Camden and Cumberland—Permo-Carboniferous Basin—*continued.*

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam.	Depth to top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
10	No. 1 Bore, Colo Vale, portion 126, parish of Colo. (By No. 3 drill.)	1884	2,000 0	Surface	.....	Not determined.		893 0	947 8	...	893—0	10 in. coal and bands.
11	No. 2 Bore, Colo Vale, portion 110, parish of Colo. (By No. A drill.)	1884	2,100 0	,, ...	450 8	450 8	811 5	811 5	837 0	1 or 2	811 5	2 in. coal.
										3	822 10	5 ft. 4 in. coal.
12	Mittagong Iron Co.'s Bore, portion 38, parish of Mittagong, county of Camden	1887	2,100 0	,, ...	605 0	.....	.....	605 0	652 10	3	605 0	32 ft. 8 in. coal and bands.
13	Cosgrove's (Mittagong) Bore, Nattai Creek, north-east corner of Cemetery.	1920	2,100 0	,, ...	593 3	.....	.....	593 3	774 5½	3	593 3	35 ft. 11 in. coal and bands.
										4	704 11	26 ft. 0½ in. coal and bands.
14	Balmoral-Hill Top, portion 69, parish of Cumbertine, county of Camden.	1910	2,000 0	,, ...	391 9	391 9	865 8	865 8	999 0	1 or 2	865 8	6 in. coal.
										3	874 3	54 ft. 9 in. coal bands.
15	Bargo Bore, V.R. 6223, parish of Bargo, Southbank, Bargo River, in north-east corner of Reserve.	1920–1921	825 0	,, ...	502 0	502 0	1,279 0	1,279 0	1,410 0	1	1,279 0	5 ft. coal.
										2	1,312 0	1 ft. 6 in. coal.
										3	1,392 0	14 ft. carbonate shale and coal.
16	Mt. Macquarie, parish of Wongawilli, county of Camden.	1917	1,720 0	,, ...	156 0	156 0	790 0	790 0	954 6	1	790 0	0¾ in. coal.
										2	814 9	9 in. coal.
										3	85 0	4 ft. coal and bands.
										4	942 0	9 ft. 2 in. coal and bands.
17	Coal, Ltd., Appin, portion 37, parish of Appin, county of Cumberland.	1914	617 9	,, ...	642 0	642 0	1,614 9	1,614 9	2,295 0	1	1,614 9	8 ft. 3 in. coal.
											1,647 5	3 ft. 4 in. coal.
											1,710 0	21 ft. 6 in. coal and bands.
											1,940 0	4 ft. 4 in. coal and bands.
18	No. 4 Bore (Metropolitan), near Harper's Creek, M.L. 24, parish of Heathcote.	1919	826 0	,, ...	256 0	256 0	1,297 0	1,297 0	1,368 0	1	1,297 0	9 ft. 2 in. coal.
						Choc. Shales = 6′ 6″ Cuprif. Tuffs = 106′ 6″.				2	1,342 0	4 ft. 3 in. coal.
19	Camp Creek, on south-south-west side of Illawarra Line, parish Heathcote, county of Cumberland. (No. 1.)	1884	836 0	.....	.....	Surface	846 0	846 0	858 0	1	846 0	12 ft. coal.

Digitized by Google

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam.	Depth to Top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
20	No. 3 Bore (Metropolitan), on M.L. 25, 70 chains west of Colliery Shaft, parish of Heathcote.	1910	642 0	Surface	262 6 Choc. Shales = 75′ 6″ Cuprifs. Tuffs = 89′	262 6	1,347 0	1,347 0	1,448 6	1 2 3	1,347 0 1,391 6 1,438 9	10 ft. 6 in. coal. 5 ft. coal. 9 ft. 9 in. coal and bands.
21	Heathcote Bore on Heathcote Creek, M.L. 19, parish of Heathcote (No. 2).	1886	468 0	,, ...	307 0 Choc. Shales = 86′ 6″	307 0	1,513 0	1,513 0	1,585 7	1	1,513 0 1,577 9	4 ft. 8½ in. coal. 6 ft. 1 in. coal.
22	No. 1 Bore, National Park, on right bank of Port Hacking River, just above Waterfall-road Crossing, parish of Bulgo, county of Cumberland.	1914	100 0	.....	.....	Surface	1,012 3	1,012 3	1,436 0	1 2 3 4	1,012 3 1,087 9 1,111 6 1,236 3 1,336 6 1,410 0	6½ in. coal and bands. 5 ft. 4 in. coal and bands. 2 ft. 9 in. coal and bands. 13 ft. 6 in. coal and bands with chert. 4 ft. stony coal and carbonaceous shale. 13 ft. 6 in. dirty coal and bands.
23	No. 2 Bore, National Park, left bank, Kangaroo Creek.	1915	.....	Surface	519 6 Choc. Shales = 110′ 9 Cuprifs. Tuffs = 62′	519 6	1,822 6	1,822 6	1,953 3	1 2	1,822 6 1,803 6 1,927 0	3 ft. coal. 5 ft. 6 in. coal. 1 ft. 3 in. coal and bands.
24	Dent's Creek Bore (Holt-Sutherland, No. 3 Bore), portion 141, parish of Sutherland, county of Cumberland.	1887	132 0	,, ...	787 1	787 1	2,228 0	2,223 0	2,307 8	1 2	2,228 0 2,296 6	4 ft. 2 in. coal. 5 ft. 3 in. coal.
25	Liverpool-Moorebank Bore, right bank George's River, portion 44, parish Holsworthy, county of Cumberland.	1889-1890	40 0	.....	.....	.....	2,493 6	2,493 6	2,601 6	1 2 3	2,493 6 2,507 7½ 2,584 10	1 ft. 5 in. coal. 1 ft. 4 in. coal. 6 ft. 6½ in. coal.

Digitized by Google

Bores in the Counties of Camden and Cumberland—Permo-Carboniferous Basin—*continued.*

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam.	Depth to Top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
26	No. 1 Cremorne Bore, Robertson's Point, Cremorne, Sydney Harbour, parish of Willoughby, county of Cumberland.	1890–1891	54 0	Surface	943 3	943 4 Choc. Shales	2,801 9 = 199'9"	2,801 9	3,095 0	1	2,801 9	8 ft. 9½ in. burnt coal.
										2	2,829 6½	1 ft. 1 in. coal.
										3	2,898 3	1 ft. 2 in. coal.
										4	2,941 2	1 ft. coal.
											2,947 2	3 in. coal.
										5	3,020 2	2 ft. 4 in. coal.
											3,030 0	1 ft. 4 in. coal.
										6	3,054 11	5 in. coal.
27	No. 2 Cremorne Bore, 40 chains north, 46° west of No. 1 Bore, parish of Willoughby.	1892–1893	143 0	,, ...	1,417 6	1,417 6	2,917 0	2,917 0	2,929 0	1	2,917 0	10 ft. 3 in. coal. 2 ft. 4 in. coal.
28	Balmain Shaft, Sydney Harbour Collieries	June, 1897, to Nov., 1902.	30 0	,, ...	1,024 9	1,024 9	2,880 0	2,880 0	3,014 2½	1	2,885 6	3 ft. 2 in. carbonaceous shale.
											2,886 2	8 in. coal.
										2	2,916 1	1 ft. 8 in. coal.
										3	2,933 10	3 in. cannel coal.
										4	2,990 3½	9 in. coal.
										5	3,007 7½	1 ft. coal.
29	Bulli, No. 1 (old) Bore, portion 7, parish of Woonona, county of Camden, on coast north side of Bulli Point.*	1891	35 0	.....	.....	.....	.....	*	803 3	†	716 11	7 ft. 4 in. coal bands.
30	Bulli, No. 2 (old) Bore, M.P. 11, parish of Woonona, county of Camden.	1892	1,594 0	Surface	854 11	854 11	711 8	711 8	865 4	1	711 8	12 ft. 8 in. (approx.) basalt and cindered coal.
										2	754 8	8 ft. 8 in. (approx.) basalt and cindered coal.
										3	798 2	60 ft. (approx.) basalt and cindered coal.
31	Bulli, No. 3 (old) Bore, M.P. 11, parish of Woonona, county of Camden.	1893	1,494 0	,, ...	597 1	597 1	956 4	956 4	1,010 7	1	956 4	6 ft. 7. burnt coal.
32	Bulli, No. 1 (new) Bore, M.L. 9, parish of Woonona, county of Camden.	1909	1,216 0	.....	.....	.....	.....	1,009 6	1,018 0	1	1,009 6	8 ft. 6 in. good coal.
33	Bulli, No. 2 (new) Bore, M.P. 18, parish of Woonona, county of Camden.	1909	1,272 0	.....	.....	.....	.....	992 0	1,000 0	...	992 0	8 ft. burnt coal.
34	Bulli, No. 3 (new) Bore, M.L. 6, parish of Woonona, county of Camden.	1910	1,278 0	.....	.....	.....	.....	1,012 0	1,020 0	1	1,012 0	8 ft. good coal.

* Surface (on lowest coal seam of Upper Coal Measures, *i.e.* on No. 7). † Tomago (or Middle) Coal Measures.

Digitized by Google

Bores in the Counties of Camden

No. on Map.	Locality.	Year.	Surface Altitude.	To—	No. of Seam	Depth to Top of Seam.	Thickness.
			ft. in.	ft. in.		ft. in.	
35	Holt-Sutherland, No. 2 Bore, close to Cronulla Beach.	.....	.....	= 1,875 0	Bore abandoned.		.....
36	Holt-Sutherland, No. 1 Bore, south-east corner, portion 39, parish of Sutherland, county of Cumberland.	1879	.....	= 2,193 0	Bore abandoned.		.....
37	Moore Park Bore, ½ mile south of southern end of Bourke-street.	1880	120 0	.....	Bore abandoned.		.....
38	Rose Bay Bore, portion 210, parish of Alexandra, county of Cumberland.	1888	.....	ot known.*	Bore abandoned.		.....
39	Newington Bore, right bank of Duck River, portion 202, parish of St. John, county of Cumberland.	1878	10 0	ndoned.	...	.....	.....
40	Narrabeen Bore (west of Narrabeen Lagoon, 7 miles north of Manly Beach, portion 77, parish of Narrabeen, county of Cumberland.	1885	5 0	ndoned.	...	.....	.....
41	Windeyer's Hawkesbury River Bore, portion 54, parish of Patonga, county of Northumberland.	1908 1910	10 0	3,005 8	1	2,322 0	3 ft. 3 in. coal.
					2	2,359 3	8 ft. 5 in. coal and bands.
					3	2,405 3	1 ft. 2 in. coal and bands.
					4	2,529 6	1 ft. 9 in. coal and bands.
						2,543 9	2 ft. coal and bands.
					*5	2,598 11	4 ft. 11 in. coal and bands.
42	Stanwell Park, No. 4, Stanwell Creek, 34 chains west of railway line, portion 58 parish of Southend, county of Cumberland.	1889	115	368 3	1	316 0	6 ft. 6 in. coal and band.
						361 9	4 ft. 6 in. coal.
43	Stanwell Park, No. 5, close to No. 1 (see below).	1903	10	259 0	1	215 0	1 ft. 11 in. burnt coal.
						228 11	4 ft. 3 in. burnt coal.

* From bottom of No. 5 seam the bo

in or dirty coal seams.

CORRIGENDUM.

Page 14.

In 4th column (Surface Altitude), third item—

for 30 0 *read* 80 0.

Digitized by Google

Bores in the Counties of Camd

No. on Map.	Locality.	Year.	Surfac Altitud
			ft.
26	No. 1 Cremorne Bore, Robertson's Point, Cremorne, Sydney Harbour, parish of Willoughby, county of Cumberland.	1890–1891	54
27	No. 2 Cremorne Bore, 40 chains north, 46° west of No. 1 Bore, parish of Willoughby.	1892–1893	143
28	Balmain Shaft, Sydney Harbour Collieries	June, 1897, to Nov., 1902.	30
29	Bulli, No. 1 (old) Bore, portion 7, parish of Woonona, county of Camden, on coast north side of Bulli Point.*	1891	35
30	Bulli, No. 2 (old) Bore, M.P. 11, parish of Woonona, county of Camden.	1892	1,594 0
31	Bulli, No. 3 (old) Bore, M.P. 11, parish of Woonona, county of Camden.	1893	1,494 0
32	Bulli, No. 1 (new) Bore, M.L. 9, parish of Woonona, county of Camden.	1909	1,216 0
33	Bulli, No. 2 (new) Bore, M.P. 18, parish of Woonona, county of Camden.	1909	1,272 0
34	Bulli, No. 3 (new) Bore, M.L. 6, parish of Woonona, county of Camden.	1910	1,278 0

* Surface (on lowest coal seam of Upper

rous Basin—*continued.*

Measures. To—		No. of Seam.	Depth to Top of Seam.		Thickness.
ft.	in.		ft.	in.	
3,095	0	1	2,801	9	8 ft. 0½ in. burnt coal.
		2	2,829	6½	1 ft. 1 in. coal.
		3	2,898	3	1 ft. 2 in. coal.
		4	2,941	2	1 ft. coal.
			2,947	2	3 in. coal.
		5	3,020	2	2 ft. 4 in. coal.
			3,030	0	1 ft. 4 in. coal.
		6	3,054	11	5 in. coal.
2,929	0	1	2,917	0	10 ft. 3 in. coal.
					2 ft. 4 in. coal.
3,014	2½	1	2,885	6	3 ft. 2 in. carbonaceous shale.
			2,886	2	8 in. coal.
		2	2,916	1	1 ft. 8 in. coal.
		3	2,933	10	3 in. cannel coal.
		4	2,990	3½	9 in. coal.
		5	3,007	7½	1 ft. coal.
805	3	†	716	11	7 ft. 4 in. coal bands.
865	4	1	711	8	12 ft. 8 in. (approx.) basalt and cindered coal.
		2	754	8	8 ft. 8 in. (approx.) basalt and cindered coal.
		3	798	2	60 ft. (approx.) basalt and cindered coal.
1,010	7	1	956	4	6 ft. 7. burnt coal.
1,018	0	1	1,009	6	8 ft. 6 in. good coal.
1,000	0	...	992	0	8 ft. burnt coal.
1,020	0	1	1,012	0	8 ft. good coal.

Middle) Coal Measures.

Digitized by Google

BORES in the Counties of Camden and Cumberland—Permo-Carboniferous Basin—*continued.*

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam	Depth to Top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
35	Holt-Sutherland, No. 2 Bore, close to Cronulla Beach.	.....	.....	.....	.....	.....	.....	Total depth =	1,875 0	Bore abandoned.		.....
36	Holt-Sutherland, No. 1 Bore, south-east corner, portion 39, parish of Sutherland, county of Cumberland.	1879	.....	Surface	880 0	880 0*	.....	Total depth =	2,193 0	Bore abandoned.		.....
37	Moore Park Bore, ½ mile south of southern end of Bourke-street.	1880	120 0	„ ...	1,043 0	1,043 0	1,060 0	.....	.....	Bore abandoned.		.....
38	Rose Bay Bore, portion 210, parish of Alexandra, county of Cumberland.	1888	.....	.....	.....	.....	.....	Depth not known.*		Bore abandoned.		.....
39	Newington Bore, right bank of Duck River, portion 202, parish of St. John, county of Cumberland.	1878	10 0	Surface	1,100 0	1,100 0	1,312 0	Bore abandoned.		...	.....	.....
40	Narrabeen Bore (west of Narrabeen Lagoon, 7 miles north of Manly Beach, portion 77, parish of Narrabeen, county of Cumberland.	1885	5 0	„ ...	370 6	379 6	1,895 0	Bore abandoned.		...	.....	.....
41	Windeyer's Hawkesbury River Bore, portion 54, parish of Patonga, county of Northumberland.	1908 1910	10 0	„ ...	294 6	294 6	2,322 0	2,322 0	3,005 8	1	2,322 0	3 ft. 3 in. coal.
										2	2,359 3	8 ft. 5 in. coal and bands.
										3	2,405 3	1 ft. 2 in. coal and bands.
										4	2,529 6	1 ft. 9 in. coal and bands.
											2,543 9	2 ft. coal and bands.
										*5	2,598 11	4 ft. 11 in. coal and bands.
42	Stanwell Park, No. 4, Stanwell Creek, 34 chains west of railway line, portion 58 parish of Southend, county of Cumberland.	1889	115 0	.....	.....	Surface	316 0	316 0	368 3	1	316 0	6 ft. 6 in. coal and band.
											361 9	4 ft. 6 in. coal.
43	Stanwell Park, No. 5, close to No. 1 (see below).	1903	10 0	.....	.....	„ ...	215 0	215 0	259 0	1	215 0	1 ft. 11 in. burnt coal.
											228 11	4 ft. 3 in. burnt coal.

* From bottom of No. 5 seam the bore penetrated 401 ft. 10 in. of strata, including seven thin or dirty coal seams.

Digitized by Google

Bores in the Counties of Camden and Cumberland—Permo-Carboniferous Basin—*continued.*

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage.		Narrabeen Stage.		Coal Measures.		No. of Seam	Depth to Top of Seam.	Thickness.
				From—	To—	From—	To—	From—	To—			
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
44	Stanwell Park, No. 1, right bank Hargraves Creek, near mouth, parish of Southend, county of Cumberland.	1883	10 0	.....	.....	Surface	186 3½	186 1½	438 0	1	186 3½	1 ft. 5 in. burnt coal.
											196 9½	5 ft. 2 in. coal.
										2	259 2½	4 ft. 5 in. coal.
										3	298 9½	22 ft. 8½ in. coal and bands.
45	Stanwell Park, No. 2, near mouth Stanwell Creek, parish of Southend, county of Cumberland.	1883	10 0	.....	.....	,, ...	192 2½	192 2½	243 10	1	192 2	1 ft. 1 in. coal.
											202 1	4 ft. 4 in. coal.
										2	238 0	2 ft. 10½ in. coal.
46	Stanwell Park, No. 3, on coast, 40 chains, south of Stanwell Creek, parish of Southend, county of Cumberland.	1886	167 0	.....	.....	,, ...	333 4	333 4	340 0	1	333 4	6 ft. 8 in. clean coal.
47	James Bore, 30 chains west of Otford Railway Station, parish of Bulgo, county of Cumberland.					No information available.						
48	Otford No. 1 Bore, 20 chains north-north-east Otford Railway Station, portion 10, parish of Bulgo, county of Cumberland.	1901	350 0	.....	.....	Surface	654 0	654 0	770 0	1	654 0	2 ft. 6 in. inferior coal.
											659 0	2 ft. 6 in. inferior coal.
										2	707 6	6 ft. inferior coal, with 1 ft. 6 in. volcanic rock.
49	Hamilton's or Riverdale-Otford Bore, 40 chains, north-north-west of Otford Railway Station, portion 4A, parish of Heathcote, county of Cumberland.	1889	320 0	.....	.....	,, ...	660 10	660 10	714 8	1	660 10	5 ft. 3 in. cindered coal.
										2	710 8	3 ft. 11½ in. coal.
50	Penrith Bore, close to Mulgoa Creek, portion 39, parish of Mulgoa, county of Cumberland.	1917 1920.	175 0	50 0 Wianamatta Stage (0 50 ft.)	1,000 0	1,060 0	2,523 0	2,523 0	2,700 0	3	2,523 0	14 ft. coal.
51	Illawarra Coke Co.'s Otford Bore, portion 2A, parish of Bulgo, county of Cumberland, 1 mile south-west of Otford Railway Station.	1917	300 0	.....	.....	Surface	705 9	705 9	721 9	1	705 9	6 in. stony coal.
											719 9	2 ft. stony coal.
52	Mullet Creek Bore, Hawkesbury River, parish of Patonga, county of Northumberland.	1879	.....	.....	.....	Total depth = 1,338'—Bore abandoned.						

Digitized by Google

Bores in the Counties of Camden and Cumberland—Permo-Carboniferous Basin—continued.

No. on Map.	Locality.	Year.	Surface Altitude.	Hawkesbury Stage. From—	Hawkesbury Stage. To—	Narrabeen Stage. From—	Narrabeen Stage. To—	Coal Measures. From—	Coal Measures. To—	No. of Seam.	Depth to Top of Seam.	Thickness.
			ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.		ft. in.	
53	Mangrove Creek Bore, Hawkesbury River, portion 30, parish of Spencer, county of Northumberland.	1878	.....	.....	.....	Total depth = 482′ 3½″—Bore abandoned.				...	.....	
54	Long Swamp Bore, Barber's Creek, near Tallong.	1883	.....	.....	Total depth = 702′ 11″—Bore abandoned.							
55	Tallong Bore, near Marulan, parish of Marulan, county of Argyle.	1883	.....	.....	Total depth = 670° 6″—Bore abandoned.							
56	Yerrinbool Bore, about 5 chains north-west from north-west corner, portion 13, parish Colo, county of Camden.	1921 1922	1,650 0	Surface	439 0	439 0	882 6 (4th Feb., 1922, in Upper Marine at 2,168 ft.)	882 6	1,600 0	1 2 3	882 6 915 0 1,009 0	2 ft. 8 in. coal. 5 ft. 9 in. coal, carbonaceous shale and stony coal. 6 in. coal bands.
57	Upper Cordeaux River Bore, on left-hand bank of Cordeaux River, on portion 221, parish of Kembla, county of Camden.	1922	1,130 0	.....	.....	Surface	323 8	323 8	.....	1 2 3	323 8 361 9 4,142 0	3ft.9in. carbonaceous shale. 1 ft. 8 in. coal and bands. 1 ft. 7 in. bright bituminous coal. 1 in. band (carbonate of iron). 1 ft. 2½ in. bright bituminous coal. 26 ft. 10½ in. coal and bands. Lower 7 ft. 7½ in. coal with two bands. Working section.
58	Douglas Park Bore, ½ mile north of Douglas Park Railway Platform, parish of Camden, county of Camden.	1923	390 0	Surface	666 0	666 0	1,687 9½	1,687 9½	1,730 0	1 2	1,687 9½ 1,728 8	8 ft. 10½ in. clean coal. 1 ft. 4 in. coal. Fireclay floor.
59	Menangle Bore, Subdivision 19, portion 5, parish of Camden, about 2 miles south-south-west of Menangle.	1923	325 0 60 ft. of Wianamatta shales.	60 0	725 0	725 0	1,794 6	1,794 6	1,843 0½	1 2	1,794 6 1,838 0	8 ft. 9 in. clean coal. 1 ft. 3 in. stony coal. ½ in. band. 1 ft. 7 in. coal and bands. Fireclay floor.

Digitized by Google

LIST OF REFERENCES.

Bore No.	Bore Locality.	Reference.
1	Bundanoon No. 1, portion 2, parish of Bundanoon, county of Camden, east of road.	Ann. Rept. Dept. Mines, 1886, p. 185.[1]
2	Bundanoon No. 2, portion 17, parish of Bundanoon, county of Camden, between Great Southern Railway and road.	Ann. Rept. Dept. Mines, 1887, p. 185.[1]
3	Joadja No. 1, parish of Joadja, county of Camden. In M.L. 27, 15 chains N.N.E. of S.E. corner, portion 69.	Ann. Rept. Dept. Mines, 1888, p. 209.[1] J. E. Carne. Mem. Geol. Survey N.S. Wales, No. 3, 1903, p. 227, and map of Joadja.
4	Joadja No. 3, near S.E. corner of portion 69, parish of Joadja, county of Camden.	Ann. Rept. Dept. Mines, 1889, p. 142.[1]
5	Joadja No. 4, near N.E. corner of portion 71, parish of Joadja, county of Camden.	Ann. Rept. Dept. Mines, 1889, p. 143.[1]
6	Joadja No. 2, near N.E. corner of portion 69, parish of Joadja.	Ann. Rept. Dept. Mines, 1888, p. 208.[1]
6A	Shale Petrol Oil Company's Bore. On M.L. 3, half a mile north-east of N.E. corner, portion 163, parish of Joadja, county of Camden.	Ann. Rept. Dept. Mines, 1922, pp. 43, 46.
7	Joadja No. 5. On Joadja Creek; exact locality not known. Portion 102, parish of Joadja, (?) county of Camden.	Ann. Rept. Dept. Mines, 1889, p. 150[1]; 1890, p. 153[1].
7A	Two bores in portion 43, parish of Joadja, County of Camden.	Mem. Geol. Survey N.S. Wales. No. 3, 1903. Geol. map of Joadja.
8	No. 1 Bore, Colo Vale, portion 51, Parish of Colo, county of Camden, No. 4 drill.	Ann. Rept. Dept. Mines, 1884, p. 171.[1]
9	No. 2 Bore, Colo Vale, portion 58, parish of Colo, county of Camden, No. 3 drill.	Ann. Rept. Dept. Mines, 1884, p. 178[1]; 1885, p. 161.
10	No. 1 Bore, Colo Vale, portion 126, parish of Colo, county of Camden, No. 3 drill.	Ann. Rept. Dept. Mines, 1884, p. 177.[1]
11	No. 2 Bore, Colo Vale, portion 110, parish of Colo, county of Camden, No. 4 drill.	Ann. Rept. Dept. Mines, 1884, p. 172.
12	Mittagong Iron Co.'s Bore, portion 38, parish of Mittagong, county of Camden.	Ann. Rept. Dept. Mines, 1887, p. 159[1], 190[1]; 1890, p. 206[1]; 1891, p. 215.
13	Mittagong. Cosgrove's Bore, Nattai Creek, near N.E. corner of Cemetery, parish of Berrima, county of Camden.	Information supplied by proprietors.
14	Balmoral-Hill Top Bore, portion 69, parish of Cumbertine, county of Camden.	Ann. Rept. Dept. Mines, 1910. pp. 75–76.
15	Bargo Bore, parish of Bargo, county of Camden, southern bank Bargo River, near N.E. corner of V.R. 6223.	Ann. Rept. Dept. Mines, 1921, p. 46.
16	Mount Macquarie Bore, near portion 92, parish of Wongawilli, county of Camden.	Ann. Rept. Dept. Mines, 1917, pp. 68 and 69.[1]
17	Coal Limited, Appin, portion 37, parish of Appin, county of Cumberland.	L. F. Harper, Mem. Geol Survey N.S. Wales, No. 7, 1915, p. 400.[1]
18	No. 4 Bore (Metropolitan), M.L. 24, parish Heathcote, county of Cumberland, near Harper's Creek.	Information supplied by colliery proprietors.
19	Camp Creek Bore. No. 1 Bore, parish of Heathcote, county of Cumberland.	Ann. Rept. Dept. Mines, 1884, p. 151. Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 183, 198, 404.[1]

[1] Denotes detailed section of bore in reference given.

Digitized by Google

LIST OF REFERENCES—*continued.*

Bore No.	Bore Locality.	Reference.
20	No. 3 Bore (Metropolitan), M.L. 25, parish of Heathcote, county of Cumberland, 70 chains W. of Colliery Shaft.	Information supplied by colliery proprietors.
21	Heathcote (Mount Westmacott) Bore, M.L. 19, parish of Heathcote, county of Cumberland.	Ann. Rept. Dept Mines, 1885, p. 176,[1]; 1887, pp. 139, 154. Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 191[1], 198. Proc. Aust. Assoc. Adv. Science, 1888, pp. 277, 281, 282, 288. Trans. Geol. Soc. Australia, 1888, I, pt. III, pp. 82–89. Geol. Survey N.S. Wales, Pal. Mem., I, 1888, pp. 1–4.
22	No. 1 Bore National Park, parish of Bulgo, county of Cumberland, on right bank of Port Hacking River, above Waterfall Road crossing.	Ann. Rept. Dept. Mines, 1914, p. 78[2]. Ann. Rept. Dept. Mines, 1915, p. 73[2], 79. Mem. Geol. Survey N.S. Wales, No. 7, 1915, p. 403.[1]
23	No. 2 Bore, National Park, parish of Bulgo, county of Cumberland, left bank Kangaroo Creek.	Ann. Rept. Dept. Mines, 1915, pp. 74[1], 79.
24	Dent's Creek Bore (Holt-Sutherland No. 3), portion 141, parish of Sutherland, county of Cumberland.	Ann. Rept. Dept. Mines, 1886, p. 189[1]; 1887, p. 139; 1887, pp. 153, 154. Min. Resources N.S. Wales, 1901, p. 314. Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 192[1], 198[2]. Records Geol. Survey N.S. Wales, IV, pt. 1, 1894. Proc. Aust. Assoc. Adv. Science, 1888, I, p. 276. Trans. Geol. Soc. Aust., 1888, I, pt. III, pp. 83–89. Pal. Mem., I, 1888, pp. 1–4.
25	Liverpool Moorbank Bore, portion 44, parish of Holdsworthy, county of Cumberland, right bank of George's River.	Ann. Rept. Dept. Mines, 1887, pp. 139, 153, 154; 1886, p. 189[1]; Min. Resources N.S Wales, 1901, p. 317. Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 195–199. Records, Geol. Survey N.S. Wales, IV, pt. 1, 1894. Ann. Rept. Dept. Mines, 1890, pp. 138–149[1]. Coal Resources N.S. Wales, 1912, p. 16.
26	No. 1 Cremorne Bore, Robertson Point, Cremorne, parish of Willoughby, county of Cumberland.	Ann. Rept. Dept. Mines, 1890, p. 163[1]; 1891, p. 152[1], and diagram 11; 1892, p. 110. Min. Resources N.S. Wales, p. 318. Records Geol. Survey N.S. Wales, IV, pt. 1, 1894. Journ. R. Soc. N.S. Wales, XXVII, 1893, p. 443. Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, pp. 299, 205.

[1] Denotes detailed section of bore in reference given.
[2] Denotes that an analysis of the coal from bore is given.

Digitized by Google

LIST OF REFERENCES—*continued.*

Bore No.	Bore Locality.	Reference.
27	No. 2 Cremorne Bore, 40 chains N. 46° W of No. 1 Bore.	Ann. Rept. Dept. Mines, 1893, pp. 69, 77; 1892, p. 27[1], diagram 2; 1893, p. 102[1].
28	Sydney Harbour Colliery, Balmain Shaft, parish of Petersham, county of Cumberland.	Ann. Rept. Dept. Mines, 1901, p. 161; 1902, p. 105; 1904, p. 113. Mem. Geol. Survey N.S. Wales, No. 3, p. 114. Mem. Geol. Survey N.S.W., No. 6, 1908, pp. 156, 160. Ann. Rept. Dept. Mines, 1907, pp. 154–161[1]. Mem. Geol. Survey, N.S.W, No. 7, 1900, p. 154; 1901, 1915, p. 204. Eng. Assoc. N.S. Wales, 18 Oct., 1900. Journ. R. Soc. N.S. Wales, XXXIII 1899, p. 107.
29	Bulli No. 1 (old) Bore, portion 7 parish of Wonona, county of Camden, on sea coast, N. side of Bulli Point.	Ann. Rept. Dept. Mines, 1891, p. 180.[1] Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 213–15.
30	Bulli No. 2 (old) Bore, M.P. 11, parish of Wonona, county of Camden.	Mem. Geol. Survey N.S. Wales, No. 7, 1915, p. 163.
31	Bulli No. 3 (old) Bore, M.P. 11, parish of Wonona, county of Camden.	Ann. Rept. Dept. Mines, 1893, p. 75.
32	Bulli No. 1 (new) Bore, M.L. 9, parish of Wonona, county of Camden.	Information supplied by company.
33	Bulli No. 2 (new) Bore, M.P. 18, parish of Wonona, county of Camden.	,, ,,
34	Bulli No. 3 (new) Bore, M.L. 6, parish of Wonona, county of Camden.	,, ,,
35	Holt-Sutherland No. 2 Bore, portion 5 parish of Sutherland, county of Cumberland, close to Cronulla Beach.	Records Geol. Survey N.S. Wales, IV, pt. II. Mem. Geol. Survey N.S. Wales, No. 7, 1915, p. 198.
36	Holt-Sutherland No. 1 Bore, S.E. corner, portion 30, parish of Sutherland, county of Cumberland.	Ann. Rept. Dept. Mines, 1879, p. 208[1]. Min. Products, 1887, plate 6. Mem. Geol. Survey N.S. Wales, No. 7, 1915, p. 198.
37	Moore Park Bore, parish of Alexander, county Cumberland, half a mile south of south-end of Bourke-street, Sydney.	Ann. Rept. Dept. Mines, 1880, p. 241. Mineral Resources N.S. Wales, 1901, p. 317. Records Geol. Survey N.S. Wales, IV, pt. 1, 1894. Mem. Geol. Survey N.S. Wales, Geol. 7, 1915, p. 198. Proc. Linn. Soc. N.S. Wales, 1881, V, pt. III, pp. 273–280. Geol. Survey, N.S.W., Pal. Mem., I, 1888, pp. 1–4.

[1] Denotes detailed section of bore in reference given.

Digitized by Google

LIST OF REFERENCES—*continued.*

Bore No.	Bore Locality.	Reference.
38	Rose Bay Bore, portion 216, parish of Alexandria, county of Cumberland.	Min. Resources N.S. Wales, 1901, p. 317. Records Geol. Survey N.S. Wales, IV, pt. 1, 1894. Mem. Geol. Survey N.S. Wales, No. 7, 1915, pp. 198–199.
39	Newington Bore, portion 202, parish of St. John's, county of Cumberland, right bank of Duck River.	Ann. Rept. Dept Mines, 1878, p. 155. Journ. R. Soc. N.S. Wales, XII, 1878, pp. 254. Proc. Aust. Assoc. Adv. Science, 1888, I. p. 275. Mem. Geol. Survey N.S. Wales, No. 7, p. 197.
40	Narrabeen Bore, portion 77, parish of Narrabeen, county of Cumberland, west of Narrabeen Lagoon, 7 miles N. of Manly Beach.	Ann. Rept. Dept. Mines, 1885, p. 130; 1887, p. 137; 1889, p. 198. Pal. Mem. Geol. Survey N.S. Wales, I, 1888, p. 44. Ann. Rept. Dept. Mines, 1890, p. 233. Min. Resources N.S. Wales, 1901, p. 317. Records Geol. Survey N.S. Wales, IV, pt. 1, 1894.
41	Windeyer's Hawkesbury River Bore, portion 54, parish of Patonga, county of Northumberland, near Croppy Creek.	Ann. Rept. Dept. Mines, 1910, pp. 68[1], 69; 1908, p. 75; 1909, pp. 69–70.
42	Stanwell Creek, 34 chains west of railway line, parish of Southend, county of Cumberland, No. 4 Drill.	Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, p. 179.
43	Close to above bore, Stanwell Park No. 5 Bore	Mem. Geol. Survey N.S. Wales, 1915, Geol. p. 177.[1] Ann. Rept. Dept. Mines, 1903, pp. 76, 77[1]; 1883, p. 181[1].
44	Near mouth of Hargraves Creek, on right bank, parish of Southend, county of Cumberland, No. 1 Bore.	Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, p. 177.[1] Ann. Rept. Dept. Mines, 1903, pp. 76 and 77[1]; 1883, p. 181.[1]
45	Near mouth of Stanwell Creek, parish of Southend, county of Cumberland. No. 2 Bore.	Ann. Rept. Dept. Mines, 1883, pp. 170, 182[1]; 1903, p. 77[1].
46	On coast, 40 chains south of Stanwell Creek, parish of Southend, county of Cumberland, No. 3 Bore	Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, p. 179.
47	James's Bore, portion 20 A, parish of Heathcote, county of Cumberland, 30 chains west of railway.	Ann. Rept. Dept. Mines, 1917, p. 70.
48	Otford No. 1 Bore, portion 10, parish of Bulgo, county of Cumberland, 20 chains N.N.E. of Otford Railway Station.	Ann. Rept. Dept. Mines, 1900, p. 115[1]; 1901, p. 91[1]; 1917, p. 70. Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, p. 183.
49	Hamilton's or Riverdale Otford Bore, 40 chains N.N.W. of Otford Railway Station, parish Heathcote, county of Cumberland.	Ann. Rept. Dept. Mines, 1889, p. 206[1]; 1917, p. 70. Mem. Geol. Survey N.S. Wales, Geol. No. 7, 1915, pp. 179–180.

[1] Denotes detailed section of bore in reference given.

Digitized by Google

LIST OF REFERENCES—*continued.*

Bore No.	Bore Locality.	Reference.
50	Penrith Bore, close to Mulgoa Creek, parish of Mulgoa, county of Cumberland.	Information supplied by propriet A. L. Davis, 17 Castlereagh- Sydney.
51	Illawarra Coke Co.'s Otford Bore, portion2 A, parish of Bulgo, county of Cumberland, 1 mile S.W. of Otford Railway Station.	Ann. Rept. Dept. Mines, 19 p. 71[1].
52	Mullet Creek Bore, Hawkesbury River.....	Ann. Rept. Dept. Mines, 18 p. 208[1] (section).
53	Mangrove Creek Bore, portion 30, parish of Spencer, county of Northumberland.	Ann. Rept. Dept. Mines, 18 plate 50[1].
54	Long Swamp Bore, Barber's Creek, near Tallong	Ann. Rept. Dept. Mines, 18 pp. 170, 192–193[1].
55	Tallong Bore, near Marulan, parish of Marulan, county of Argyle.	No reference.
56	Yerrinbool Bore, about 5 chains north-westerly from N.W. corner portion 13, parish of Colo, county of Camden.	Ann. Rept. Dept. Mines, 19 p. 46; 1922, p. 49[1].
57	Upper Cordeaux River Bore, portion 221, parish of Kembla, county of Camden.	Ann. Rept. Dept. Mines, 19 p. 92.
58	Douglas Park Bore, half a mile north of Douglas Park Railway Station.	See p. 6.
59	Menangle Bore, portion 5, parish of Camden, county of Camden.	See p. 6

[1] Denotes detailed section of bore in reference given.

[1 Map and 1 Diagram (folders).]

Sydney: Alfred James Kent, Government Printer—1924.

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, Government Geologist.

MINERAL RESOURCES

No. 33.

THE GYPSUM DEPOSITS OF NEW SOUTH WALES

BY

LEO J. JONES,
Geological Surveyor.

Issued by direction of the Hon. J. C. L. Fitzpatrick, M.L.A., Minister for Mines.

SYDNEY: ALFRED JAMES KENT, GOVERNMENT PRINTER.

1925.

† 61165—a [2s. 6d.]

Digitized by Google

Science Library
TN
122
.N421
A3
no. 33

Digitized by Google

TABLE OF CONTENTS.

PAGE.

I. INTRODUCTION 5

II. HISTORICAL 6

III. GYPSUM 8

(*a*) Chemical and Physical Properties 8

(*b*) Varieties—

Rock Gypsum, Seed Gypsum, Gypsite Selenite, Satin-spar 8

(*c*) Anhydrite 9

(*d*) General mode of occurrence 10

(*e*) Origin 10

(1) Deposition from solution 10

(2) Deposits produced by disintegration and mechanical reaccumulation 11

(3) Deposits produced by alteration 11

(*f*) Uses of Gypsum 11

(A) Raw or Uncalcined—

(1) Portland Cement 11

(2) Agricultural purposes 11

(3) Flux 12

(4) Sculpture 12

(5) Insecticides 12

(6) Sulphuric Acid 13

(7) Miscellaneous 13

(B) Calcined—

Classification of Plasters, Plaster of Paris, Cement Plaster, Flooring Plaster, Hard Finish Plaster 13

IV. THE GYPSUM INDUSTRY 14

Statistics 14

V. GYPSUM DEPOSITS OF THE STATE 16

(1) Hillston District 18

(2) Trida–Ivanhoe District 21

(3) Wentworth District 33

(4) Balranald District 36

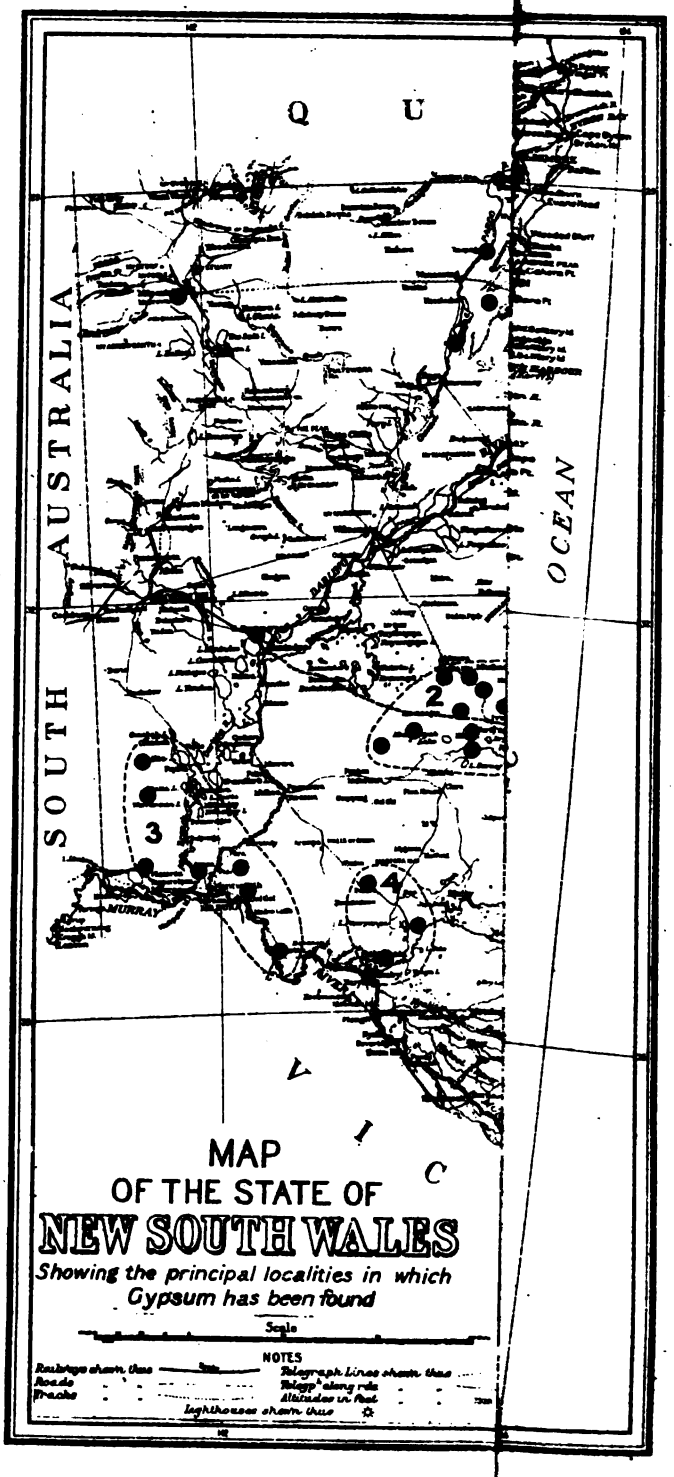
(5) Miscellaneous Occurrences 38

INDEX 43

Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google

I.—INTRODUCTION.

Though the occurrence of extensive superficial deposits of gypsum in the far western portion of New South Wales has been known for many years, but little attention has been given to their development owing to the absence of railway facilities and their long distance from central markets.

Rock or massive gypsum—the variety generally mined for industrial purposes—has not yet been recorded in New South Wales, but gypsite, or earthy gypsum, occurs in large quantities, and as it is in part of high-grade quality, it should be suitable for most purposes.

Gypsum, being bulky for its value, cannot be successfully worked if subject to excessive haulage charges, and as the deposits of this State are situated at considerable distances from Sydney, the chief market centre, the question arises as to whether these occurrences can be profitably worked in competition with the imported product.

New South Wales has so far been dependent for its supplies of crude gypsum upon the neighbouring States of South Australia and Victoria, while the calcined product, plaster of Paris, has been imported from overseas. One company is now engaged in the State in the manufacture of plasters, and though a little local gypsum is used in their works, the bulk of their supplies is drawn from South Australia.

When the Condobolin railway line was extended to Trida a few years ago, a little prospecting for gypsum was undertaken and a number of mining leases for this mineral taken up, but so far only a small tonnage has been raised. The extension of this railway line from Trida to Broken Hill (now being constructed) will render a number of gypsum deposits commercially accessible, and as there is a continually increasing demand for gypsum and the various products manufactured from it, there is every possibility of some of these deposits that have lain dormant so long being successfully mined.

As the gypsum deposits of the State are for the most part superficial in their occurrence and their outcrops largely masked with sand and clay, but little detailed information can be given concerning them until further prospecting work has been done to test their extent, thickness, and quality.

The analyses quoted are only to be taken as indicative of the general composition of each deposit; reliable results will only be revealed when careful bulk-sampling over wide areas has been carried out.

Digitized by Google

II.—HISTORICAL.

THE first published account of the occurrence of gypsum in New South Wales is contained in the late C. S. Wilkinson's (Government Geologist) Report of Progress of the Geological Survey of New South Wales for 1884, in which he states* :—"Between 12 and 30 miles from Ivanhoe (on the road to Mount Manara) are several remarkable basin-shaped hollows from 30 to 40 feet deep and from 15 to 30 chains in diameter. . . . The soil in banks around these swamps contains nodules of marl and gypsum, especially at the Gypsum Palace Inn. Here and for 2 miles beyond large quantities of crystalline and earthy gypsum crop out in low rises which are covered in places with red sand."

Professor A. Liversidge, in a report on the "Minerals of New South Wales" (London, 8vo, 1888, p. 164), records the occurrence of gypsum from several localities in New South Wales.

Mr. G. W. Card, Curator, Mining Museum, in "Mineralogical Notes," published in the "Records of the Geological Survey of New South Wales (1902–1905)," records further occurrences of gypsum (selenite).

Analyses of this mineral have been published from time to time in the Annual Reports of this Department, samples having been submitted for examination.

In 1915 Mr. Joseph E. Carne, late Government Geologist, furnished a report on the limestone and gypsum deposits of the Murrumbidgee Irrigation area.†

A short note on the "Occurrence of Gypsum in New South Wales" was included as Appendix I in the "Report on the Limestone Deposits of the State."‡

Dr. Anderson, in "Bibliography of Australian Minerals,"§ and O. Trickett, in "Bibliography of Economic Minerals of New South Wales,"‖ record several localities in which gypsum occur.

Neglecting the small quantities of gypsum mined for purely local use at Wentworth, Balranald, and Gypsum Palace, since the early days of settlement at these places, the first gypsum raised within the State, according to official returns, was during the year 1904, when 1,000 tons were obtained from Yanco Glen, Broken Hill district. The gypsum was required for the manufacture of sulphuric acid, used in the salt-cake process in work at the Broken Hill Proprietary mine, when the acid flotation process was first introduced for the concentration of metallic ores. The following year gypsum, to the value of £1,295 is recorded¶ as having been raised at Yanco Glen, after which operations ceased.

---

* Ann. Rept., Dept. Mines, N.S. Wales, 1884, p. 146.
† Ann. Rept., Dept. Mines, 1916, pp. 190–193.
‡ Min. Res Series. No. 25, Geol. Sur. N.S. Wales, 1918, pp. 384-392.
§ Min. Res. Series, No. 22, Geol. Sur. N.S. Wales, 1916, p. 67.
‖ Min. Res. Series, No. 26, Geol. Sur. N.S. Wales, 1919, p. 5.
¶ Ann. Rept. Dept. Mines, 1905, p. 55.

Digitized by Google

To face page 6.

Gypsite Ridge—Gypsum Palace.

Gypsum Palace Inn.

Constructed of blocks made from burnt gypsite and ashes—erected 1856.

Digitized by Google

Digitized by Google

It was not until the Condobolin–Broken Hill railway line had been completed as far as Trida that any further attempt was made to work the extensive deposits known to occur in the western portion of the State.

In 1921 the Western Gypsum Company raised 300 tons from the Trida deposits, and in the two succeeding years 1,692 tons and 2,070 tons respectively were mined from these deposits.

The Water Conservation and Irrigation Commission have recently acquired gypsum deposits at Doolitty Swamp (near Goolgowi), Yeltie, and Beilpargerie, from which they propose to obtain the necessary supplies of gypsite for the agricultural requirements of the settlers on the Murrumbidgee Irrigation area

A number of mineral leases to mine for gypsum have recently been granted in the Trida–Ivanhoe district. These will doubtless be worked when the railway, now in course of construction, is extended beyond the present railhead at Trida.

Digitized by Google

III.—GYPSUM.

(*a*) Chemical and Physical Properties.

The mineral gypsum, when absolutely pure, is a hydrous sulphate of lime made up of one molecule of lime sulphate combined with two molecules of water, and has the chemical formula $CaSO_4 + 2H_2O$. Reduced to its ultimate components, the percentage composition is as follows:—

			Per cent.
Gypsum, $CaSO_4 + 2H_2O$	Lime Sulphate $CaSO_4$	Lime CaO	32·6
		Sulphur trioxide SO_3	46·5
	Water H_2O		20·9
			100·0

Commercial deposits of gypsum are never of this purity, varying percentages of sand, clay, limestone, magnesian limestone, iron oxide, &c., being present.

Pure gypsum is white, but it may be grey, yellow, red or brown due to the presence of impurities.

Gypsum occurs in both crystalline and massive form. The crystalline variety is transparent to translucent, while the massive gypsum is sometimes glistening, but frequently with a dull earthy appearance. Gypsite, a soft powdery form of gypsum, is white gray, buff, creamy, or pinkish in colour, depending upon the nature of the impurities present.

Gypsum is distinguished from most minerals by its softness, being readily scratched by the finger-nail. It does not effervesce with acids, and can thus be distinguished from limestone. The specific gravity of the pure mineral ranges from 2·30 to 2·33.

Gypsum, when calcined and mixed with water, will set or harden, and can be used as a wall plaster.

(*b*) Varieties of Gypsum.

Owing to differences in form, texture, colour, and other physical characters, gypsum presents several varieties, the most important being—(1) Rock Gypsum, (2) Seed Gypsum, (3) Gypsite, (4) Selenite, and (5) Satin-spar.

(1) *Rock Gypsum.*—Rock or massive gypsum occurs interbedded with sedimentary rocks. It presents considerable variation in colour, texture, and structure. When pure the colour is white, but as impurities are commonly present it may be greyish-white, grey, brown, blue, or pink. The colour may be evenly distributed, banded, or mottled in the rock. The texture may range from coarsely crystalline to finely granular. In structure it may show distinct bedding planes along which it breaks easily, or it may occur as a compact body devoid of bedding planes or joints.

When very fine grained, white, and slightly translucent, rock gypsum is known as *alabaster* and is used for statuary and art purposes.

Rock gypsum occurs in beds ranging from thin layers covering small areas to deposits 60 feet or more thick and extending for many miles. It is this variety of gypsum which furnished most of the material requried for industrial purposes.

Digitized by Google

Bedded deposits of rock gypsum have not yet been recorded in New South Wales, though crystalline nodules, up to 18 inches in diameter, are frequently found scattered throughout a clay bed of recent origin.

(2) *Seed Gypsum*, or gypsum sand, consists of small crystals of gypsum which have been derived from the disintegration of larger masses (rock gypsum or crystalline nodules) of gypsum. This variety usually occurs in the form of "dunes"—wind-blown accumulations.

(3) *Gypsite*, or earthy gypsum, is a soft powdery form of gypsum, which occurs as superficial deposits frequently in and around areas of depression. It is composed of microscopic plates of crystalline gypsum contaminated with clay, sand, and other impurities. In colour it may be white, grey, creamy, brownish, yellowish, or pinkish, depending largely on the impurities present. Gypsite may be so powdery as to resemble wood ashes, and ranges through sandy and earthy phases to a form that is slightly consolidated.

Gypsite deposits range in thickness from a few inches to several feet, and extend over areas ranging up to 1,000 acres.

Gypsite deposits can be worked with a pick and shovel; in most cases with a shovel alone. Some deposits are more compact and harder than others, the hardening being due to the action of surface waters dissolving the calcium sulphate and reprecipitating it in a crystalline spongy form.

Gypsite is fairly widespread in its occurrence in the western portion of New South Wales, and constitutes the most important of the gypsum deposits of the State.

(4) *Selenite* is a variety of gypsum which occurs in distinct crystals of the monoclinic system, or in broad folia. It is generally colourless and transparent, and splits into sheets, which are slightly flexible, but not elastic like the mineral mica.

Selenite occurs as veins or crystals in massive gypsum, or as plates and crystals in clays, shales, and limestones. It is also met with as a gangue mineral in lodes and reefs, and has been recorded from a number of localities in the State, but it does not occur in commercial quantities.

(5) *Satin Spar* is a crystalline fibrous variety of gypsum. It is usually white or cream coloured, and occurs in narrow veins or seams either in massive gypsum deposits or in close proximity to these deposits, and has been formed by deposition from gypsum-bearing waters. It does not occur in commercial quantities.

(c) Anhydrite.

Anhydrite is a mineral closely related to gypsum in its composition and mode of origin. It is composed of calcium sulphate without any water of crystallisation; is in other parts frequently found associated with gypsum. By the absorption of two parts of water anhydrite turns to gypsum, and this is supposed to be one of the actions occurring in nature, resulting in the formation of beds of gypsum from anhydrite, in which condition the rock was first deposited.

Anhydrite might easily be mistaken for gypsum, which it closely resembles, but it is the heavier and harder of the two minerals, and moreover it possesses two directions of cleavage, whereas gypsum has only one. The presence of anhydrite in gypsum is undesirable, and if present in quantity the gypsum would be useless for the manufacture of plaster of Paris. So far anhydrite has not been recorded from New South Wales.

Digitized by Google

(*d*) General Mode of Occurrence.

Gypsum occurs as beds, lenticular intercalations and irregular masses, in sedimentary rocks, and is usually associated with beds of red clay, rock-salt limestone, or anhydrite; as efflorescent deposits, formed at the surface by the evaporation of water carrying sulphate of lime in solution; as veins or irregular masses, generally composed of satin spar or selenite, precipitated from solution in fissures, cracks, and bedding planes; as dunes, wind-borne accumulations of gypsum sands and gypsite derived from the disintegration of massive or crystalline gypsum; as isolated crystals in shale and clay deposits; also in lode formations usually precipitated as the result of the action of sulphuric acid on calcium carbonate; and as periodic lake deposits, formed by the crystallisation of gypsum from the waters of intermittent shallow lakes.

(*e*) Origin.

Gypsum deposits may be formed as the result of:—

(1) Deposition from solution in (*a*) sea water, (*b*) ground water.

(2) Disintegration and reaccumulation of pre-existing deposits.

(3) Alteration.

1. *Deposition from* (a) *Sea Water.*—Evaporation of salt water in enclosed seas results in the precipitation of the contained salts, of which calcium sulphate constitutes 3·6 per cent. Gypsum is not deposited until 80 per cent. of the water is evaporated. The great thickness of some bedded deposits would necessitate the evaporation of such enormous quantities of sea water that no known ocean basin would hold it. To meet this objection it is considered that if an arm of the sea is cut off by a bar, which permits influxes of the sea at irregular intervals and at such a rate as to enable evaporation to keep pace with it, fairly thick deposits of gypsum may accumulate. The great thickness of a gypsum bed may also have resulted from currents shifting the unconsolidated gypsum along the bottom of the basin in which it is being formed.

(1) *Deposition from solution in* (b) *Ground Water.*—Water percolating through gypsum-bearing strata may take up calcium sulphate in solution and subsequently deposit it in joints, fissures, and bedding planes as selenite, satin spar, or in irregular shaped masses of crystals.

Certain deposits of gypsite or earthy gypsum are of the nature of "spring" deposits, percolating water dissolving sulphate of lime from the rocks it traverses and depositing it at the surface, where it issues as a spring.

The majority of the gypsite deposits of New South Wales, however, are not of the nature of "spring" deposits. In nearly every case they are found to occur in and around low-lying swamp-like areas (drainage basins) in the great alluvial plains of the western portion of the State where the rainfall is low and the summer temperatures very high. The lime in the soil may originally have been derived from the weathering and decomposition of pre-existing carbonates and from lime-silicate minerals of igneous or metamorphic rocks. Under the influence of sub-arid weathering the solubility of gypsum enables it to be taken into solution and brought to the surface by capillarity, there to be deposited and to be subsequently taken up by surface drainage and redeposited in larger bodies in favourable localities. Given a suitable depression in which water is, or at one time has been held long enough to be evaporated the gypsum in the water is precipitated as small crystals.

Digitized by Google

To face page 10.

A typical Gypsite deposit on the margin of a swamp.

Prospecting a Gypsite deposit near Trida.

Digitized by Google

Digitized by Google

When the whole of the water in the marsh or lake has been evaporated the gypsum is exposed on the bed of the lake, and under the influence of the hot sun it breaks into the micro-crystalline powder known as gypsite or "kopi." This material is carried by the prevailing winds to the lee side of the swamp, where it accumulates as a more or less defined ridge. Portion of the gypsum may be carried by percolating solutions beneath the bed of the swamp and at a shallow depth precipitated in nodular crystalline form. The nodules are irregular in shape and vary in size from 1 inch to 18 inches in diameter, and are composed of crystals radially disposed. They occur scattered through a clay bed, which may vary from 3 to 20 feet in thickness.

(2) *Disintegration and Reaccumulation of Pre-existing Deposits.*—Dunes of gypsum sands and gypsite are occasionally met in gypsum-bearing areas where wind erosion is active. The gypsum sand is derived from the disintegration of "rock" or crystalline gypsum exposed at the surface, while gypsite ridges are wind-borne accumulation of powdery gypsum that have been formed as lake or spring deposits.

(3) *Alteration.*—Gypsum may result through the decomposition of sulphides and the action of the resultant sulphuric acid upon limestone, the reaction being :—

$$H_2SO_4 + CaCO_3 = CaSO_4 + H_2O + CO_2.$$

The small crystals or plates of gypsum so frequently found in clay and shale deposits have probably been formed by the decomposition of pyrites which gives rise to sulphuric acid and soluble sulphates that act upon any lime present and convert it into gypsum.

Gypsum may also be formed by the action of sulphurous acid, given off by volcanoes, upon rocks which contain lime.

Anhydrite by absorbing water recrystallises and alters to gypsum.

(*f*) Uses of Gypsum.

Gypsum, both in the raw and calcined condition, is used in many industries.

(A) Raw or Uncalcined.

(1) *Portland Cement Manufacture.*—Either raw or calcined gypsum is universally used to retard the setting of Portland cement. Raw gypsum is generally used on account of its cheapness as compared with the calcined product; from 2 to 3 per cent. is added to the clinker before final grinding.

Sulphur trioxide (SO_3) is the active agent in gypsum which renders it valuable as a cement retarder, and while it is desirable that the SO_3 content of gypsum for use in cement manufacture should exceed 40 per cent., lower grade material carrying 35 per cent. can be used with satisfactory results. Gypsite, when of sufficient purity, is quite suitable for this purpose.

Approximately 4,000 tons of crude gypsum are used annually in New South Wales in the manufacture of Portland cement.

(2) *Agricultural Purposes.*—To be suitable for agricultural uses gypsum should be in a fine state of division. Gypsite and "seed" gypsum (small wind-blown crystals) are suitable for direct application to the soil, but the more massive crystalline varieties must first be finely ground.

Digitized by Google

Gypsum is used as a fertiliser and for deflocculating heavy clay soils.

As a fertiliser gypsum acts both (*a*) directly and (*b*) indirectly.

(*a*) *Directly.*—Sulphur is now recognised as an important plant food, and gypsum supplies this ingredient direct to the soil.

Gypsum increases the protein content in legume hays, lucerne, clover, and similar crops. It improves the root system of lucerne and better results are obtained when it is used.

(*b*) *Indirectly.*—Gypsum indirectly tends to increase the nitrogen in the soil by stimulating the growth of nitrogen fixing bacteria.

Potash, present in an insoluble form in most soils, is made soluble and available for plant life by the reaction of gypsum on the potash silicates.

Gypsum counteracts the injurious effects of certain salts, *i.e.*, magnesium sulphate, magnesium chloride, sodium carbonate, and sodium chloride, that are present in many soils.

Gypsum has a tendency to flocculate loose soils—that is, to collect the loose particles and give the soil more body. With a tough clay soil it has the opposite effect, and tends to break up the hard clay pan and render the soil more permeable and amenable to working.

The moisture-holding properties of soil are considerably improved by the application of gypsum.

The development of irrigation in the Murrumbidgee area has created a demand for gypsum, chiefly for the purpose of deflocculating heavy soils.

A series of experiments have recently been carried out at Yanco with the object of ascertaining if beneficial results are to be expected from an application of gypsum to the soil, and it has been reported that* :—"Gypsum promises to be of immense benefit to settlers. . . . It has been found that where a dressing of gypsum has been given the texture of the soil is much improved. A point much in its favour is that the land dries more evenly, and it is possible to get on to it and to cultivate it from one to two days earlier, thus conserving moisture that would otherwise be lost by evaporation. The land also cultivates much more easily, and is more mellow and friable. After heavy rain the soil does not set so hard; in fact, cases have been noted where water lies on the surface of the untreated land, whereas on the gypsum-dressed soil no surface water is to be seen."

On one farm a dressing equivalent to 1 ton of gypsite per acre was applied to portion of an apricot orchard, and it was found that "while the trees that received the gypsum returned a crop of good apricots, not a single fruit was picked from the untreated row, those that did form being very small and failing to mature."

(3) *Flux.*—Crude gypsum is sometimes used as a flux in smelting, particularly for oxidised nickel ores.

(4) *Sculpture.*—The pure white, semi-transparent variety of gypsum (alabaster) is used for statuary and other art decorations.

(5) *Insecticides.*—Finely ground raw gypsum is used to dilute arsenic poisons marketed as insecticides.

* "Soil Improvement on Yanco Irrigation Area," *Agric. Gazette of N.S. Wales*, vol. xxxiv, pt. 8, Aug., 1923, pp. 503-4.

Digitized by Google

(6) *Manufacture of Sulphuric Acid.*—Numerous patents have been issued for extracting sulphuric acid from gypsum. Germany has been credited with obtaining her supplies of this acid from gypsum during the last years of the war. Other attempts do not appear to have been commercially successful.

(7) *Miscellaneous Uses.*—Gypsum, when finely ground and known as Terra Alba, is used as a filler in the manufacture of paper and cotton. It is also used in the manufacture of rubber goods, phonograph records, paints, calcimines and crayons; for oil filtration, imitation marble, in brewing and chemical work, and as a deodoriser.

(B) Calcined.

If pure crude gypsum be heated to a temperature of more than 212° F., and less than 400° F., a certain definite portion of the water of combination will be driven off, and the gypsum thus partially dehydrated will be plaster of Paris, and if finely ground will harden or set very rapidly when mixed with water. This property of "setting" constitutes the chief commercial importance of calcined gypsum.

By varying the rate and intensity of burning or by the addition of ingredients that modify the character of the plaster, many special cements are made.

Gypsum plasters are classified by Eckel as*:—

"A.—Produced by the incomplete dehydration of gypsum, the calcination being carried on at a temperature not exceeding 400° F.

(1) Produced by the calcination of a pure gypsum, no foreign materials being added either during or after calcination—*Plaster of Paris.*

(2) Produced by the calcination of a gypsum containing natural impurities or by the addition to a calcined pure gypsum of certain materials which serve to retard the set of the product—*Cement Plaster.*

"B.—Produced by the complete dehydration of gypsum, the calcination being carried on at a temperature exceeding 400° F.

(3) Produced by the calcination of a pure gypsum—*Flooring Plaster.*

(4) Produced by the calcination, at red heat or over, of gypsum to which certain substances (usually alum or borax) have been added—*Hard Finish Plaster.*

The uses of calcined gypsum (plaster) are many and varied, among which are the following:—

Interior Decorations.—Calcined gypsum is required chiefly for the manufacture of plasters for use in the interior decorations of buildings, for covering walls, ceilings and floors; for the manufacture of fibrous plaster ceilings, wall plates, plaster boards or sheets, balustrades, handrails, cornices, mouldings, and such like; for making gypsum blocks for use in construction of partitions, floors, roofs; and its uses in these directions are constantly increasing. Its high fire-resisting properties makes it especially valuable for this class of work. It is also used for outside work on buildings intended

* "Cements, Limes and Plasters," E. C. Eckel, New York, 1909, p. 32.

Digitized by Google

for temporary use, such as decorative exhibition buildings; generally, for other than stucco and similar purposes, it is not suitable for permanent outside work, because it will not withstand exposure to wind and rain.

Modelling.—For taking casts of original work where it is desired to make reproduction in other material; for modelling statuary, relief maps, and models of all kinds.

Moulds.—Used largely in making moulds for all descriptions of work—i.e., for pottery and porcelain manufacture and foundry work.

Miscellaneous.—Dental mouldings, surgical casts and bandages, pipe and boiler covering, plate glass polishing, briquetting brown coal, fire-proof safe construction.

The Gypsum Industry of New South Wales.

The gypsum industry of New South Wales is only in its infancy, due undoubtedly to the absence of easily accessible local deposits of gypsum, and the State's requirements have, for the most part, been met by importing from other places.

The Australian Gypsum, Ltd., was the first company, formed in 1914, to operate in New South Wales. This company held 200 acres of gypsum leases in the hundred of Warrenben, near Marion Bay, Yorke Peninsula, South Australia, and erected a small plant (kettle process) on the Duck River, at Auburn, near Sydney, for the manufacture of plaster of Paris. The crude gypsum being shipped direct from South Australia to Sydney, thence by barges to the works.

The plant originally installed consisted of "a rotary crusher, two initial buhr mills, one 8 feet kettle, one vibrating screen, one regrinding buhr mill, one mixer and a hair picker, together with the usual elevators, conveyors and transmission machinery complete. The plant being driven by three electric motors totalling 85 h.p."*

So far this company is the only one in the State at present engaged in the manufacture of plaster.

The Western Gypsum Company was floated in 1917 with the object of opening up some of the gypsum deposits in the vicinity of Trida, and has since amalgamated with the Australian Gypsum, Ltd., and the gypsum now being raised at Honeycomb is forwarded to Auburn for calcining.

The following table shows the amount of gypsum so far raised in New South Wales :—

Gypsum Raised in New South Wales.

Year.	Amount.	Value.
	tons.	£
1904	1,000	(?)
1905	(?)	1,295
1921	300	210
1922	1,692	402
1923	2,070	360

* "Mineral Industry, 1915," vol. xxiv, p. 281.

Digitized by Google

The following table shows the amount and value of gypsum and the calcined product imported from overseas since 1918 :—

GYPSUM IMPORTS.

Year.	Crude Gypsum.	Value.	Calcined Gypsum.	Value.
	cwt.	£	cwt.	£
1917–1918	178	54	2,889	1,984
1918–1919	20	8	11,280	8,993
1919–1920	220	78	15,540	8,720
1920–1921	220	77	24,120	16,206
1921–1922	275	80	21,494	13,592
1922–1923	631	220	28,786	15,058

The above table does not include the crude gypsum or the calcined product imported from the neighbouring States of South Australia and Victoria, the figures of which are not available.

The demand for crude gypsum is continually increasing, the beneficial effects derived from its application to various soils is only just becoming known, and the requirement for gypsite for agricultural purposes will rapidly increase if the material can be purchased at a reasonable cost. The steady increase in the yearly output of Portland cement demands larger quantities of crude gypsum.

The manufactured products of calcined gypsum are in ever-increasing demand, so that the future of the gypsum industry in the State is well assured.

Digitized by Google

IV.—GYPSUM DEPOSITS OF NEW SOUTH WALES.

Gypsum has been recorded from a number of localities in New South Wales, but in many cases only as a mineral occurrence and not as a deposit of economic value.

With the exception of the gypsite deposit at Doolitty Swamp, 6 miles west-north-west of Goolgowi, all the known deposits of sufficient size and purity to be of economic importance occur west of the 145th parallel of east longitude. In this sparsely populated portion of the State, extending from the Murray River to the Queensland border, gypsum deposits are fairly common, associated with the Pleistocene and Recent superficial accumulations of the Western Plains.

Two varieties of gypsum are commonly met with, viz.:—(*a*) Nodular crystalline gypsum, and (*b*) gypsite or earthy gypsum, both of which occur in and around low-lying swamp areas in the vast western alluvial plains:—

(*a*) *Nodular Crystalline Gypsum* usually occurs as irregular shaped nodules scattered through a clay bed which may vary from 3 to 20 feet in thickness. In such deposits the gypsum is rarely found outcropping at the surface, being for the most part cloaked with an overburden, ranging from 2 to 7 feet of soil and clay. The commercial importance of such deposits depends primarily on its location with respect to lines of transportation and market; and secondly upon the amount of overburden, the thickness of the clay bed and the proportion of gypsum (which must be hand picked) to the enclosing clay. The nodules, though irregular in shape, are somewhat cylindrical with the crystals radially disposed. Thin seams of clay and clayey partings are invariably present. They range in size from a few inches to 18 inches in longest diameter. The percentage of gypsum to the enclosing clay bed may vary from less than 10 to about 40 per cent.

The following are typical average analysis of these crystalline nodules:—

Assay No.	Locality.	$CaSO_4$.	H_2O.	MgO.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Total.
20/3836	Wee Elwah	67·11	18·19	trace	...	1·64	16·80	99·90
20/3778	Canoble	65·47	...	...	...	3·74	11·49	...
20/3784	Gypsum Palace ...	65·01	...	...	...	5·98	12·82	...
21/109	Tiarri.....	61·57	19·40	0·03	1·76	2·76	14·36	99·88

As will be seen from the above analyses, the presence of sand and clayey impurities have a marked effect upon the composition of the nodular gypsum as mined. The sulphur-trioxide contents, ranging from 36·21 to 39·47 per cent. is just sufficiently high for the gypsum to be acceptable for use in the manufacture of Portland cement, but the material without preliminary crushing and washing is not sufficiently pure to be suitable for high-grade plaster manufacture.

The nodular variety of crystalline gypsum is widespread in its occurrence west of the 145th parallel of longitude, and is usually to be seen in the excavation heaps around tanks and wells that have been sunk in the vicinity of swampy or depressed areas.

Digitized by Google

So far but little has been done to prospect these deposits, and in most cases there are no particulars available as to the thickness of the gypsum-bearing clay bed or the relative percentage of gypsum present, only isolated nodules on the spoil heaps to indicate the existence of gypsiferous clay. The prospecting work carried out at Tiarri, Canoble and Gunbar would seem to indicate that these deposits of nodular gypsum, owing to the nature of the occurrence, poor quality, costly working and transportation charges, are not likely to be profitably worked with gypsum at its present selling price.

Another variety of crystalline gypsum, spongy or honeycomb-like in appearance, occurs in lenticular horizontal layers associated with gypsite at Trida and Marlow. The crystalline texture appears to be due to the action of surface waters dissolving the gypsum and reprecipitating it in crystalline form. Further prospecting work will probably reveal the occurrence of this material in other localities.

Typical average samples of this "spongy" gypsum contain from 55 to 65 per cent. of calcium sulphate; usually a fair amount of clay is present in the interstices.

(*b*) *Gypsite or Earthy Gypsum*, also known locally as "Kopi," is the earthy variety of gypsum and is frequently contaminated with sand, silt, and more rarely with organic matter; it is usually associated with travertine. Gypsite occurs as a superficial deposit ranging from a few inches to several feet in thickness, and extending over areas ranging up to 1,000 acres in extent. It has been formed by the breaking down of the more massive forms of gypsum. (See p. 10.) Arid and semi-arid regions are frequently characterised by deposits of this nature. Gypsite when dry is a fluffy powder, whitish to yellowish in colour. It generally outcrops at the surface, but at times it is liable to be masked by a shallow covering of sand or soil. Sometimes gypite overlies a clay bed containing nodules of crystalline gypsum, and in rare instances beds of the "spongy" crystalline variety are intercalated with it. Generally it is found to occur as low mounds or ridges on the lee side of swamps or areas of depression.

The following are typical average analyses of the better grade gypsite :—

Locality.	$CaSO_4$.	Fe_2O_3 and Al_2O_3	Gangue.	Equivalent Gypsum content.
Marlow	77·79	0·26	2·32	98·38
Trida	60·18	1·48	12·76	76·11
Balranald	69·28	1·80	9·41	87·60
Gol Gol	70·46	0·28	6·10	89·14

When sufficiently pure gypsite is suitable for Portland cement and plaster manufacture, also for agricultural purposes; the material being in a very fine state of division it is suitable for direct application to the soil.

A good market exists for this material on the Murrumbidgee Irrigation area.

Very little prospecting work has yet been done to test the thickness and extent of the various gypsite deposits, and no reliable estimate can be furnished as to the actual tonnage of material available. Nevertheless there are a number of deposits of considerable magnitude situated within reasonable distance of the Condobolin–Broken Hill railway line now under construction and it will doubtless be worked in the near future.

Digitized by Google

The gypsite being soft and purely a superficial deposit is cheaply mined. In most cases it can be dug with a shovel, and neither picks nor explosives are needed. The usual practice is to use a horse-scoop to excavate the material.

As only a portion of the Western Plains has been examined, doubtless many other deposits of gypsum will subsequently be added to the present known occurrences, but their long distance from rail will prevent their commercial exploitation.

The gypsum deposits of the State, reasonably accessible and of sufficient size and purity to be of economic value, may be conveniently grouped for descriptive purposes under the following districts :—

(1) Hillston district.
(2) Trida–Ivanhoe district.
(3) Wentworth district.
(4) Balranald district.
(5) Miscellaneous occurrences.

Hillston District.

Within this area occurs the gypsite deposit of Doolitty Swamp, which, though small, is important in being within a short distance of the Murrumbidgee Irrigation area, which requires considerable quantities of this material for agricultural purposes.

The other deposits within this area are small and of but little commercial importance.

(*a*) *Doolitty Swamp.*—Portion 21, parish Warrabalong, county Nicholson. Situated about 5 miles west of Goolgowi railway siding, 425 miles from Sydney.

An extensive deposit of earthy gypsum (gypsite) occurs along the sides and bottom of the low box swamp adjoining Doolitty Tank. The gypsum occurs scattered over a wide area, approximately 70 chains long by 40 chains wide. In places the outcrop is masked by a few inches of red sandy soil, and in the swampy area the gypsum is covered by a foot or more of sand and clayey material. In places the gypsum is associated with sandy soil and nodular travertine to such an extent that it becames too impure for commercial purposes.

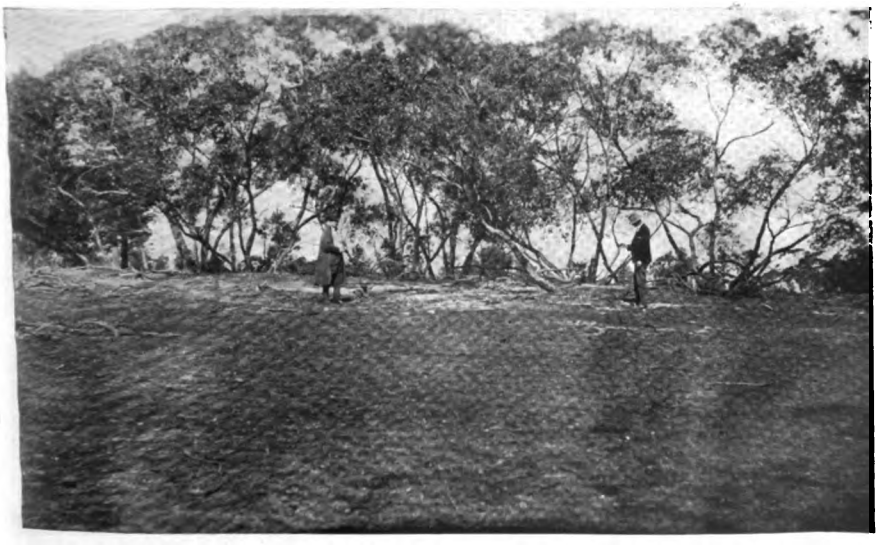
The best portion of the deposit occurs on the south-eastern margin of the swamp, where it forms a low ridge extending from the southern boundary of portion 21 in an east-north-easterly direction, a distance of approximately 70 chains. The outcrop is practically continuous for this distance and has an average width of 50 feet.

The following section was measured at the south-western end of the low gypsum ridge :—

	ft.	in.
Earthy gypsum, floury white in colour	1	3
Earthy gypsum with sand and a little seed gypsum, characterised by a distinctly reddish tinge	1	6
Reddish sand with nodules of travertine and an occasional layer of impure earthy gypsum	2	6
Thin bands of hard travertine and sand	Floor.	

Digitized by Google

A typical outcrop of Gypsite—Gypsum Palace.



Doolitty Swamp—Gypsite ridge.

Digitized by Google

Digitized by Google

Average samples were obtained of (1) the top 1 ft. 3 in. of earthy gypsum, and (2) of the underlying 1 ft. 6 in. of earthy gypsum, seed gypsum and sand, and on being analysed in the Departmental laboratory yielded the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 1 ft. 3 in.	59·42	1·40	18·24	75·14	31·42
Gypsite seed	...	...	...	...	...
Gypsum, and sand, 1 ft. 6 in.	24·86	2·42	54·20	31·24	...

Further samples were obtained at 15 chains intervals along the gypsum ridge and analysed with the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, Sample 3, 15 chains from No. 2, Top 1 ft. 4 in.	53·86	...	21·46	68·11	31·68
Gypsite, Sample 4, 15 chains from No. 3, Top 1 ft. 4 in.	57·94	1·70	20·50	72·27	34·08
Gypsite, Sample 5, 15 chains from No. 4, Top 1 ft. 2 in.	63·86	1·60	12·94	80·76	37·56
Gypsite, Sample 6. From S.E. end of ridge, Top 1 ft. 3 in.	63·80	...	11·10	80·69	37·52
Gypsite, seed gypsum and sand, Sample 7, Bottom 1 ft. 5 in.	23·44	...	46·24	29·64	...

The section measured at the south-west end of the gypsum outcrop is characteristic of the whole length of the low ridge. The top layer, from 1 ft. 2 in. to 1 ft. 6 in. in thickness, is a fair-grade earthy gypsum carrying from 53 to 63·86 per cent. of calcium sulphate. Beneath this is about 1 ft. 4 in. to 1 ft. 6 in. of inferior gypsum, contaminated with sand, carrying from 23 to 24 per cent. of calcium sulphate. This poorer grade gypsum has a characteristic reddish tinge, quite distinct from the floury white colour of the top layer.

At an approximate depth of 2 ft. 6 in. from the surface nodular travertine makes its appearance and the gypsum contents falls to a negligible quantity.

The sampling of this deposit, carried out by the Irrigation Commission, showed that isolated patches of high-grade material occurs beyond the ridge sampled by the writer, but investigation shows that such high-grade material is confined to small patches, and the gypsum on the north west side of the swamp, and in the bed of the swamp itself, is for the most part contaminated with sand and travertine to such an extent as to render the winning of it unprofitable.

Digitized by Google

A sample taken by Mr. Joseph E. Carne (late Government Geologist) from a shaft 5 ft. 6 in. deep at the lower end of the box swamp yielded on analysis the following results :—

Assay No. 15/3827—	Per cent.
Silica	29·44
Alumina	6·90
Ferric oxide	2·50
Ferrous oxide	...
Manganese carbonate	0·06
Calcium carbonate	22·91
Magnesium carbonate	14·47
Barium carbonate	Absent.
Strontium carbonate	1·45
Calcium sulphate	11·92
Phosphoric acid	0·05
Water	10·32
Alkalies, organic matter, &c.	...
	100·22

This analysis may be taken as typical of the area away from the low ridge.

The total area over which fair-grade gypsum (averaging 50 to 60 per cent. calcium sulphate) occurs at Doolitty Swamp is approximately 230,000 square feet, and, assuming an average depth of 1 foot, there is available between 5,000 and 6,000 tons of this material. Of the lower grade gypsum (containing from 20 to 25 per cent. calcium sulphate) approximately 8,000 to 10,000 tons are present.

In my opinion the amount of fair-grade material is too limited to warrant the expense of linking up this deposit with a branch line to the Hillston–Griffith railway.

(*b*) *Sylvanham*, portions 10 and 12, parish Synnott, county Nicholson. Situated about 11 miles west of the Hillston railway line and about 17 miles by existing roads to Goolgowi railway station.

There is no surface indication of the occurrence of gypsum at this locality, but in the material excavated from the tank occasional small crystals of gypsum occur in a clayey matrix associated with nodular travertine. The gypsum is too sparsely scattered to permit of profitable working.

(*c*) *Gunbar, Hillman's Tank*, portion 128, parish Honuna, county Nicholson. Situated about 3 miles south of Gunbar, and 22 miles by existing roads to Goolgowi railway station.

There is no natural outcrop of gypsum at this locality, but large nodules, up to 1 foot in diameter, of the crystalline variety, are to be seen on the embankment surrounding the tank, which were evidently dislodged while excavating.

A shaft sunk close to the tank shows the gypsum to occur at a depth of 7 feet from the surface as nodules scattered irregularly through a clay bed 8 feet thick.

This deposit is evidently of very limited extent, as other prospecting shafts close by failed to locate any further gypsum.

Digitized by Google

A sample of the gypsum obtained from the side of the tank yielded on analysis :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Nodular gypsum, Hillman's Tank	54·41	2·32	22·10	68·81	32·0
" " " "	70·91	2·00	8·30	89·78	41·71

The gypsum is of poor quality, as the " nodules " include much clayey material, and in my opinion this deposit, owing to its quality, limited extent, amount of overburden, and distance from railway could not be commercially exploited.

(2) *Trida–Ivanhoe District.*

Within this area are included all the known deposits of gypsum situated within a reasonable distance of the Condobolin–Broken Hill railway line now under construction.

If the gypsum deposits of the State are ever to be utilised for the manufacture of plaster, this is the district from which supplies will be drawn.

The little prospecting work so far done to test the gypsum deposits of the State has been carried on within this area, but a good deal has yet to be done before reliable estimates can be furnished as to the quantity and quality of material available.

Gypsum, both the crystalline and earthy forms, is widespread in its occurrence throughout the Trida-Ivanhoe district, and is usually to be found in and around the low-lying or swampy areas which characterise this portion of the State.

Irregular-shaped nodules of crystalline gypsum are to be seen in most of the excavation heaps around the tanks and wells of the district, notably at Wee Elwah, Trida, Nintie, Mintiney, Tiarri, Canoble, King, Waverley, Maybah, Tickatoe, Bilbie, White Hills, Boundary Dam, Kilfera and Bonuna. It would appear as if the nodular crystalline gypsum would be found by sinking shallow shafts in any of the swampy areas that are so common in this district.

The commercial importance of these deposits depends upon the amount of overburden; the thickness of the clay bed containing the nodules, and the proportion of gypsum to the enclosing clay, and can only be determined after extensive systematic prospecting work has been carried out.

The few deposits of nodular gypsum so far prospected would appear to be costly to mine, and subject to such heavy cartage charges to rail, that it is doubtful if they could be profitably worked at the present market value of gypsum.

Earthy gypsum or gypsite occurs as a superficial deposit, and is frequently masked by a shallow covering of sand. It is usually found as low ridges on the leeward side of swampy tracts. The thickness of the deposits ranges from a few inches to 8 feet, and almost invariably the top 2 feet constitutes the best portion of the deposit. Occasionally " spongy " gypsum—a crystalline variety resembling honeycomb in structure—occurs in lenticular horizontal layers associated with gypsite.

Digitized by Google

Wee Elwah.—W.L.L. 100, parish Wee Elwah, county Mossgiel. Situated about 6 miles south-west of Wee Elwah railway station, 451 miles from Sydney.

There are no surface indications of the occurrence of gypsum here, but small nodules, up to 3 inches in diameter, of crystalline gypsum were obtained when sinking a tank, and fragments are to be seen in the excavation heaps. No particulars regarding the extent of this occurrence are available.

A sample of the gypsum from here yielded on analysis the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum.....	67·11	2·20	11·88	84·47	39·47

Trida.—Trida is the present terminus of the Condobolin–Broken Hill railway line, now under construction, 466 miles from Sydney.

A number of important gypsum deposits occur in this locality.

(1) *Honeycomb.*—Situated about 10 miles north-north-east of Trida railway station, in parishes Nintie and Tinkoh, county Mossgiel.

Four mining leases—M.Ls. 3, 4, 6 and 7—have been secured by the Western Gypsum Company. Several shafts were sunk, and a number of trenches and shallow cuts opened up, revealing a considerable quantity of spongy gypsum with intercalated bands of gypsite. Very little gypsum is to be seen at the surface here, being for the most part masked by a thin covering of sand and soil, but the area of depression, representing the position of an ancient lake or swamp, in which the deposit occurs, is approximately 60 acres, and the gypsum may ultimately be found to extend over the greater portion of the area.

The following is a typical section exposed in the company's workings :—

	ft.	in.
Surface soil—up to	2	0
Gypsite	0	6
Spongy gypsum with irregular layers of gypsite	1	9
Spongy gypsum	1	3
Gypsite with clay	1	0
Clay with nodular travertine (floor)	...	

Average samples taken from one of the working faces yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 9 in.	60·18	1·48	12·76	76·11	35·39
Spongy gypsum 2 ft. 9 in.	61·37	1·36	14·10	77·61	36·10
Average from face, 3 ft. 6 in.	58·51	2·46	16·40	74·00	34·42

A small tonnage of gypsum has been won from this deposit, the method of working being to scoop the surface soil and then blast the gypsum, the working face ranging from 3 ft. 3 in. to 4 ft. The gypsum is carted to Trida siding,

Digitized by Google

To face page 22.

Gypsite workings, Honeycomb.

Horse-scoop removing overburden, Honeycomb, near Trida.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

and is shipped to the Australian Gypsum Company, Sydney, who are using it in the manufacture of plaster. A little of the gypsum from here has also been used in the manufacture of Portland cement.

(2) *M.Ls.* 1 and 2, parish Nintie, county Mossgiel. Situated about 2 miles north-west of Honeycomb, and 11 miles north of Trida.

A limited outcrop of gypsite occurs here, but further prospecting is necessary to determine the thickness and extent of the deposit.

(3) *Special Lease*, 320 acres, parish Nintie, county Mossgiel. Situated about 2 miles west of Honeycomb, 9 miles north of Trida.

A limited exposure of gypsite occurs on the margin of an extensive area of depression, and will possibly be found to extend over a considerable area beneath a mantle of soil, as shallow shafts, sunk away from the outcrop, have revealed gypsite up to 2 ft. 6 in. in thickness at a depth of from 9 inches to 1 foot from the surface. An average sample taken from a shallow cut, from which a limited amount of gypsite has been won, yielded on analysis :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 2 ft.	63·37	5·10	12·56	80·14	37·27

Until this deposit has been systematically prospected, it is impossible to even roughly estimate the extent of gypsum likely to be won here, but there is little doubt that a considerable tonnage is available.

The gypsite of this deposit is admirably suited for agricultural requirements.

(4) *M.L.* 5, parishes Nintie and Papatoitoi, county Mossgiel. Situated about 3 miles west of Honeycomb, and 9 miles north of Trida.

A fairly extensive ridge of gypsite, 35 chains long, from 5 to 10 chains wide and 10 feet in height, occurs on the eastern side of a swamp. Prospecting shafts reveal from 2 to 4 feet of gypsite overlying "spongy" gypsum. Further systematic prospecting is necessary here in order to determine the thickness and extent of the "spongy" variety. An average sample of the gypsite yielded on analysis :—

Description.	$CaSO_4$.	Equivalent Gypsum content.	SO_3.
Gypsite, 4 ft. section	67·87	85·83	39·92

This material is of excellent quality and should be suitable not only for agricultural purposes, but also for cement manufacture and certain plasters.

(5) *M.L.* 1, parish Papatoitoi, county Mossgiel. Situated 1¼ mile south-west from Honeycomb, and 8 miles north-north-east of Trida.

A fairly extensive outcrop of gypsite occurs here on the north-eastern side of a depressed area, estimated to cover approximately 50 acres. Auger borings show the gypsite to range from 2 to 7 feet in thickness, but the lower portion is contaminated with clay, sand and travertine.

Digitized by Google

An average sample of the top 3 feet of the gypsite yielded on analysis :—

Description.	$CaSO_4$.	Equivalent Gypsum content.	SO_3.
Gypsite, 3 ft. section	58·26	73·68	34·27

About 1½ mile west of M.L. 1 gypsite again outcrops, and extends in disconnected patches over an area of approximately 30 acres. An average sample of the top 12 inches yielded on analysis :—

Description.	$CaSO_4$.	Equivalent Gypsum content.	SO_3.
Gypsite, 1 ft. section	72·20	91·31	42·43

This is a particularly high-grade sample of gypsite. Systematic prospecting work is necessary to test the thickness and extent of this deposit.

(6) *Mintiney Well*, parish Tinkeh, county Mossgiel. Situated about 13 miles north-north-east of Trida railway siding.

Nodules of crystalline gypsum occur in the embankment around the Mintiney Well, and south-east of the tank is a limited exposure of gypsite.

(7) *Tiarri*.—East of Tiarri homestead, parishes of Tiarri and Nintie, county Mossgiel. Situated about 13 miles north of Trida railway station.

An extensive ridge of gypsite, approximately 80 chains long, 2 to 7 chains wide, and up to 25 feet in height, occurs on the north-easterly side of a swampy area, 1 mile east of Tiarri homestead.

No prospecting work has yet been done on this deposit, but undoubtedly a large tonnage of gypsite is available.

An average sample of the top, 2 ft. 6 in. taken from the crest of the ridge, yielded on analysis :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 2 ft. 6 in. section	57·47	3·74	16·82	72·68	33·80

On the south-western side of the swamp, in portion 6, parish Nintie, nodular crystalline gypsum is exposed in shallow cuts and shafts. The overburden is from 2 to 6 feet, and the clay bed containing the nodules about 7 feet in thickness.

Digitized by Google

A sample of the gypsum yielded on analysis :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum	61·57	2·76	14·36	77·86	36·21

Possibly the nodular gypsum will be found to extend over the whole of the low-lying area, but it is doubtful if it can be profitably mined.

Two miles east of the previously described occurrence is another exposure of gypsite estimated to cover 35 acres. A few pot holes sunk on this deposit show the gypsite to range from 1 ft. to 3 ft. 6 in. in thickness.

An average sample of the top 2 feet yielded on analysis :—

Description.	$CaSO_4$.	Equivalent Gypsum content.	SO_3.
Gypsite, 2 ft. section	70·17	88·74	41·27

(8) *Patterson's Tank*, parish Tiarri, 15 miles north-west of Tiarri homestead.

Nodular gypsum occurs in the spoil heap around the tank. No details of the occurrence are available.

(9) *Four-mile Tank*, parish Tibara, 4 miles west-north-west of Tiarri homestead.

A small outcrop of gypsite occurs on the north-western side of Four-mile Tank. No prospecting work has yet been done on this deposit.

(10) *Ninty Tank*, parish Murringobunni, county Mossgiel, 10 miles west-south-west of Tiarri homestead.

Nodules of crystalline gypsum occur in the excavation heaps around Ninty Tank, and a small low ridge of gypsite occurs on the eastern side of the tank.

(11) *Marlow*.—M.Ls. 4, 5, 6, 7 and 8, parish Cameron, county Mossgiel, 14 miles north of the Broken Hill railway line now under construction.

An extensive deposit of gypsite, associated with spongy gypsum, occurs about 3 miles north of Marlow homestead. Here the outcrop is approximately 120 chains long by 50 chains wide. Possibly the gypsite will be found to extend over a much larger area beneath a thin cloaking of sand. It outcrops not only on the low ground, but also forms low ridges up to 10 feet in height. Auger boring tests show that the gypsite ranges from 2 ft. 6 in. to 8 ft. in thickness, and is of excellent quality. In places spongy gypsum occurs, intercalated with the gypsite. A shaft sunk near the northern end of the deposit revealed the following section :—

	ft.	in.
Gypsite	1	3
Spongy gypsum	3	6
Gypsite and clay	0	6
Clay with travertine (floor)	.....	

Digitized by Google

Several samples were taken from this deposit which yielded on analyses the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 1 ft. 9 in.....	72·55	3·15	1·10	3·84	91·75	42·66
,, 1 ft. 6 in.....	77·55	...	0·42	2·86	98·07	45·61
,, 2 ft. 6 in.....	77·79	...	0·26	2·32	98·38	45·75
Gypsite, M.L. 4, 3 ft.	65·17	...	...	...	82·42	38·33
Spongy gypsum west of M.L. 4, 2 ft. section	53·88	...	...	...	68·14	31·69
Gypsite north of M.L. 5, Top 9 in.	66·58	...	...	...	84·21	38·93

The gypsite as revealed in a foregoing analyses is of excellent quality—in fact, is the purest yet sampled in the State, and compares favourably with the best-grade gypsum from South Australia. It is eminently suitable for the manufacture of high-grade plasters, for Portland cement, and ideal for agricultural purposes.

The spongy variety, though of much poorer quality, should be suitable for the manufacture of certain plasters, but is too low in sulphur-trioxide content for use in Portland cement. Further prospecting is needed to test the extent of this "spongy" gypsum, and doubtless higher-grade material, at least comparable with that from Honeycomb, whose gypsum contents averages 77 per cent., should be located.

Assuming the gypsite to average only 2 feet in thickness over the whole deposit, it is estimated that 600,000 tons are available.

(12) *Marlow.*—M.L. 1, parish Cameron, county Mossgiel. Situated about 5½ miles north-west of Marlow homestead, and 14 miles north of the railway line under construction.

Gypsite here outcrops disconnectedly over an area of approximately 20 acres. In places it is masked by a thin covering of sand. The gypsite ranges from 1 ft. 6 in. to 4 ft. 6 in. in thickness and overlies a clay bed with nodular travertine. An average sample of the top 2 feet yielded on analysis the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 2 ft. section.....	70·93	1·12	0·98	8·06	89·70	41·72

(13) *Marlow.*—M.Ls. 2 and 3, parish Cameron, county Mossgiel. Situated about 4 miles west of Marlow homestead and 12 miles north of the railway line under construction.

Digitized by Google

Gypsite occurs here in the form of a low ridge approximately 40 chains long and from 2 to 5 chains wide. The actual thickness of this deposit has not been ascertained. The following sample was taken to a depth of 1 ft. 6 in. :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 1 ft. 6 in.	72·21	0·64	5·64	91·32	42·48

(14) *Canoble.*—Portion 1 and M.Ls. 1 and 2, parish Yaradah, county Mossgiel. Situated from 3 to 4 miles north of the railway under construction.

Nodules of crystalline gypsum occur in the excavation heaps around the Canoble homestead tanks on portion 1, and also around the Government Canoble Tank, about 1 mile further south.

A number of prospecting shafts have been sunk in the vicinity of the Government Tank, revealing the following section :—

Soil and clay ... ... 4 to 6 feet.
Clay with nodules of gypsum ... ... 7 feet.
Brown clay with travertine ... ...

The gypsum constitutes about 25 per cent. of the clay bed containing it. A few tons of nodular gypsum are lying stacked around the tank and one 5-ton load has been carted 18 miles to Trida siding.

These tanks are situated within the margin of the Canoble Swamp, and doubtless further prospecting work would reveal a considerable extension of the gypsum-bearing clay bed, but it is very doubtful if it could be profitably worked.

The following samples obtained from these deposits yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum, Canoble homestead...	57·49	4·82	18·66	72·71	33·81
Crystalline gypsum, Govt. Tank, Canoble	65·47	3·74	11·49	82·80	38·51

An average sample, taken over the whole depth, 7 ft., of the clay bed carrying the gypsum, yielded on analysis :—

$CaSO_4$	7·63
$CaCO_3$	10·35
Fe_2O_3 and Al_2O_3	11·64
Gangue	58·82

An interesting feature in connection with this deposit is the association of amorphous strontianite, in the form of small irregular nodules, which occurs spasmodically distributed throughout the clay bed in which the gypsum occurs.

Digitized by Google

An average sample of this material yielded on analysis :—

	per cent.
$SrSO_4$	89·32
$BaSO_4$	4·54
$CaSO_4$	7·06
Fe_2O_3 and Al_2O_3	0·78
SiO_2	2·30
H_2O	1·10
	99·60

Soluble chlorides—a minute trace.

(15) *Canoble.*—Maybah Tank, M.Ls. 2, 3 and 4, parish Waiko, county Mossgiel. Situated 15 miles north-east of Ivanhoe and 8 miles north of the railway line under construction.

A low ridge of gypsite, approximately 35 chains long, with a width ranging from 2 to 6 chains, occurs on the eastern side of Maybah Tank, on the Waiko-Ivanhoe road. Test holes reveal a thickness from 1 to 4 feet of gypsite resting on a clay bed with nodules of travertine.

So far no prospecting work has been done on this deposit.

The following average samples yielded on analysis the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, west end, 2 ft. 3 in.....	67·66	3·84	8·10	1·30	85·57	39·80
Gypsite, south end, 2 ft.	67·35	3·85	9·12	1·50	85·17	39·63
Gypsite, middle, 3 ft. 6 in.....	64·88	2·69	1·84	11·11	82·05	38·16

(16) *Canoble.*—Waiko, M.L. 1, parish Waiko, county Mossgiel. Situated 14 miles north-east of Ivanhoe, and 9 miles north of the railway line under construction.

Impure gypsite occurs on the north-eastern side of a depressed area 1½ mile north-west of Maybah Tank, and outcrops disconnectedly over an area 20 chains long by 12 chains in width.

No prospecting work has yet been carried out on this deposit.

(17) *Canoble.*—King's Well, portion 3, parish Lang-Cal-Cal, county Mossgiel. Situated 7 miles south of Canoble homestead, and 3 miles south of the railway line under construction.

Irregular-shaped nodules of crystalline gypsum are abundantly distributed throughout the excavation heaps around King's Well.

No details are available. An average sample yielded the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum, King's Well	65·34	3·00	12·54	82·63	38·44

Digitized by Google

(18) *Canoble.*—Waverley Tank, portion 9, parish St. Monans, county Mossgiel. Situated 9 miles south of Canoble homestead, and 5 miles south of the railway line now under construction.

Nodules of crystalline gypsum occur in the embankment around Waverley Tank, but no information regarding the thickness or depth of the gypsiferous clay bed is available.

An average sample yielded on analysis :—

Locality.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Waverley Tank	59·92	3·62	17·46	75·78	35·24

(19) *Canoble.*—Portion 1, parish Ballah, and portion 3, parish Gunnabouna, county Mossgiel. Situated 6 miles south-south-east and 7 miles south-west respectively of Canoble homestead, and within 1 mile of the railway line.

Small nodules of gypsum occur in the embankments around the tanks on the above portions. No details are available.

(20) *Ivanhoe.*—White Hills, M.Ls. 1 and 2, parish Ivanhoe, county Mossgiel. Situated about 12 miles east of Ivanhoe, and 1½ mile north of the railway line now being constructed.

An extensive ridge of impure gypsite occurs on the eastern side of White Hills Swamp, close to White Hills Tank. The ridge trends north-north-easterly and south-south-westerly, and is approximately 80 chains in length and from 3 to 15 chains wide. The gypsite is for the most part very impure, and in places is cloaked with sand.

A sample taken from the southern end of the ridge, 1 ft. 3 in. in thickness, yielded on analysis 55·17 per cent. gypsum. Samples taken further north along the ridge only yielded from 16 to 35 per cent. of gypsum.

The gypsite sampled is too poor grade for commercial purposes, but systematic prospecting would probably reveal material of better quality.

(21) *Ivanhoe.*—Ticehurst, Tickatoe Tank, parish Ticehurst, county Mossgiel. Situated 10 miles north-east of Ivanhoe, and 7½ miles north of the railway line.

Nodules of crystalline gypsum occur in the embankment surrounding Tickatoe Tank, but no particulars as to the extent of the deposit are available.

(22) *Ivanhoe.*—Ticehurst, Bilbie Well, parish Ticehurst. Situated 7 miles north-north-east of Ivanhoe.

Nodules of gypsum are to be seen in the excavation heaps at Bilbie Well, and a small outcrop, largely masked with sand, of gypsite occurs in the vicinity of the well.

(23) *Ivanhoe.*—Boundary Dam, portion 11, parish North Abbotsford, county Mossgiel. Situated about 6 miles south of Ivanhoe.

A limited exposure of gypsite occurs in the vicinity of Boundary Dam, but so far no prospecting work has been done there.

(24) *Yeltie.*—Portion 9, parish Yeltie, county Manara. Situated about 8 miles south-west of Ivanhoe, and 5 miles south of the railway line under construction.

Digitized by Google

An extensive deposit of gypsite occurs here, forming a series of low ridges, up to 20 feet in height, between two swamp areas. The ridges trend north-easterly and south-westerly, and extend over an area of approximately 35 acres. No prospecting work has yet been done to test the thickness and extent of this deposit, but a few shallow holes sunk when procuring samples showed the gypsite to range from 2 to 5 feet in thickness.

Average samples taken from this deposit yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	$CaCO_3$.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, south end of ridge, 2 ft. 6 in.	62·06	3·72	2·80	5·64	78·48	36·50
Gypsite, north end of ridge, 2 ft. section	65·02	2·08	4·38	9·46	82 23	38·24
Gypsite, west end of ridge, 2 ft. 6 in.	42·98	...	...	...	54·35	25 28
Gypsite, central portion, Top 1 ft. 3 in.	63·76	...	...	...	80·64	37·5
Gypsite, central portion, 2 ft. section	47·47	...	...	...	60·03	27·92
Gypsite, central portion, from 1 ft. to 2 ft. 4 in.	46·96	...	...	...	59·39	27·62

From the above analyses it will be seen that the gypsite shows considerable variation in quality, but the top 12 to 15 inches is generally high grade.

Until systematic prospecting work is carried out here and the deposit thoroughly sampled, estimates as to quantity can only be of a very approximate nature.

Possibly 50,000 tons of good-grade gypsite, averaging from 75 to 85 per cent. gypsum, might be won from here.

(25) *Umalee.*—W.L. 461, parish Umalee, county Manara. Situated 12 miles west-north-west of Ivanhoe, and 5 miles north of the railway line.

Gypsite outcrops on the eastern side of an area of depression near the south-eastern corner of W.L. 461.

The outcrop is more or less continuous for a length of 35 chains over a width ranging from 5 to 20 chains. Possibly the gypsite will be found, beneath a thin covering of sand, to extend over a much larger area.

No prospecting work has yet been done, but auger boreholes revealed the gypsite to vary from 12 in. to 3 ft. 6 in. in thickness resting upon a clay bed containing nodules of travertine.

Samples obtained from here yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content	SO_3.
North end of deposit, 2 ft. thick	77·79	0·24	1·62	9[illegible]·38	45·76
South end of deposit, 3 ft. 6 in. thick	74·29	0·38	4·72	93 96	43·70

Digitized by Google

To face page 30.

Gypsite—Gypsum Palace.

Gypsite ridge between swampy areas, Yeltie, near Ivanhoe.

Digitized by Google

Digitized by Google

The gypsite is thus particularly high grade; it is snowy-white in colour and should be suitable for high-grade plaster work and for use in the manufacture of Portland cement.

Possibly 50,000 to 75,000 tons of high-grade gypsite is available here.

(26) *Beilpagerie.*—Portion 2, parish Casey, and T.S.R. 14,038, parish Amoona, county Manara. Situated about 29 miles west of Ivanhoe, and 6 miles south of the railway line now under construction.

Extensive deposits of gypsite occur on the eastern side of a swamp in the vicinity of Beilpagerie out-station. A few chains north of the homestead is a ridge of gypsite approximately 50 chains long, from 5 to 15 chains wide, and rising to a height of 30 feet.

Samples taken from this deposit yielded on analyses the following results :—

Description.	$CaSO_4$.	Equivalent Gypsum content.	SO_3.
Northern end of deposit, 2 ft. 6 in. section	60·67	76·73	35·68
Centre of ridge, auger bore sample, 1 ft. 9 in.	58·23	73·64	34·25
Southern end, 2 ft. 4 in. section...	42·22	53·39	24·83

The sample from the southern end of this occurrence is very poor grade, but as it was taken near the margin of the deposit contamination with clay was to be expected. The few sampling holes sunk on this deposit show the gypsite to be from 2 to 6 feet deep, below 2 feet there is an appreciable increase in the amount of clay present. Further sampling and prospecting work are necessary to determine the thickness and quality of the gypsite available here. It can, however, be safely assumed that an area of 40 acres to a depth of 2 feet will yield 80,000 to 100,000 tons of gypsite of suitable grade for agricultural purposes.

Two miles west of Beilpagerie homestead, on the main travelling stock route to German Tank, gypsite again outcrops and persists in isolated patches for 3 miles, occurring in the form of low ridges trending approximately north and south. These deposits appear to be of similar quality to that at Beilpagerie, and are situated at from 5 to 6 miles south of the railway line under construction.

No prospecting work has yet been done on these deposits, but undoubtedly a large tonnage of gypsite is available here.

(27) *Prince's Lake.*—Parish Pentole, county Manara. Situated about 13 mile ssouth-west of Beilpagerie station.

It has been reported that extensive deposits of gypsite occur in the vicinity of Prince's Lake and extend in a north-westerly direction towards Overneutee Dam.

(28) *Bonuna Tank.*—Tank Lease 64, parish Bonuna, county Manara. Situated 17 miles north-north-west of Ivanhoe.

Nodules of crystalline gypsum are sparsely distributed through the spoil heaps surrounding Bonuna Government Tank, close to the Ivanhoe-Wilcannia road.

Digitized by Google

A sample ontained from here yielded on analyses the following results :—

Description.	$CaSO_4$.	$CaSO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline nodules, Bonuna Tank	59·87	1·43	1·72	20·60	75·72	35·21

(29) *Gypsum Palace.*—Western Lease 464, parish Kilfera, county Manara. Situated 27 miles north-west of Ivanhoe. The most extensive outcrop of gypsite yet recorded in the State occurs at the south-eastern edge of a large basin-shaped depression, 27 miles north-west of Ivanhoe.

The gypsite outcrops over an area 2½ miles long by 1½ mile wide in places forming prominent ridges, ranging from 15 to 20 feet in height, which have a general north and south trend; the intervening hollows are largely covered with red sand. Crystals of selenite up to 3 inches in length are frequently seen embedded in the surface crust of the gypsite.

No prospecting work has yet been done on this deposit, but auger boreholes in places penetrated 7 feet without reaching the bottom of the deposit.

Two average samples obtained from this deposit yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, 3 ft. section, southern end	71·50	1·34	7·50	90·42	42 05
Gypsite, 2 ft. 6 in. section, northern end	69·22	1·66	9·40	87·54	40·72

The gypsite is of excellent quality and suitable for both Portland cement and plaster manufacture, and though an enormous tonnage of high grade material is available it cannot at present, owing to its location 27 miles from rail, be profitably worked

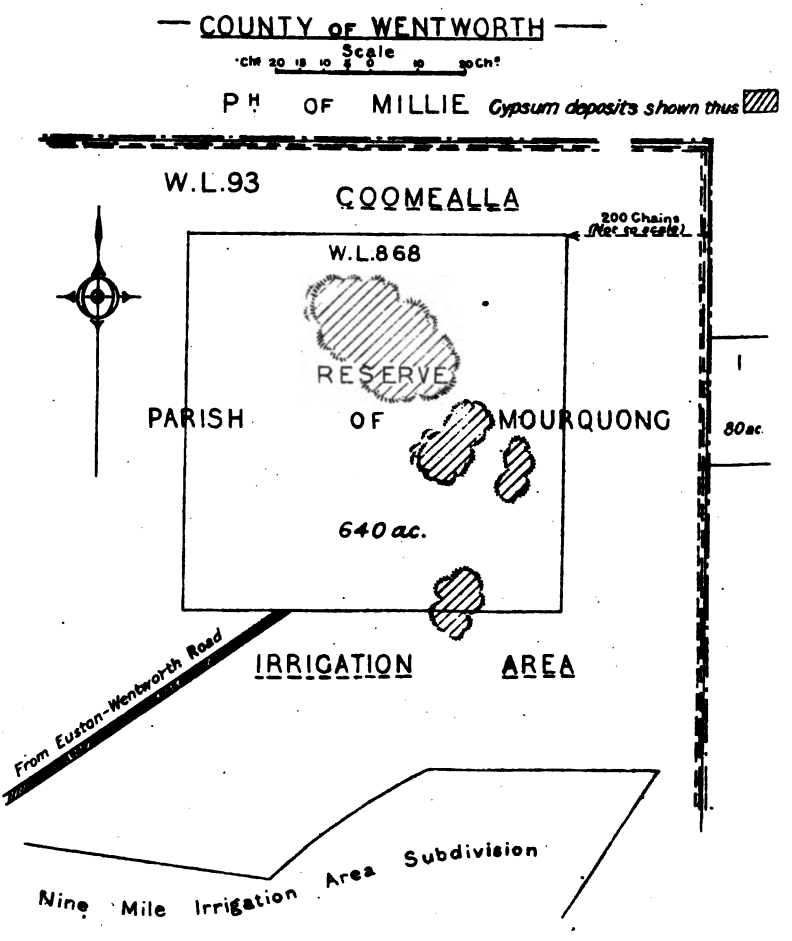
The "Gypsum Palace" homestead is constructed of plaster made from this gypsite, which was mixed with ashes and moulded into large blocks. Though erected seventy years the structure has well withstood the ravages of time.

(30) *Gypsum Palace.*—Moore Tank, portion 2, parish Kilfera. Situated 2 miles north-north-west of Gypsum Palace.

Large nodules of crystalline gypsum are abundant in the embankment surrounding Moore Tank, which lies on the eastern side of the large gypsite deposit. No particulars are available regarding the thickness or extent of the clay bed containing the gypsum nodules, but at a private tank, half a mile south-easterly from Moore Tank, the gypsum nodules are again met with. Possibly the crystalline gypsum will ultimately prove to extend over a wide area.

Digitized by Google

Digitized by Google



Digitized by Google

Average samples obtained from these tanks yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_4.
Crystalline gypsum, Moore Tank.....	65·01	4·88	9·88	82·22	38·23
Crystalline gypsum, Private Tank, near Gypsum Palace	61·52	5·98	12·82	77·80	36·18

(31) *Gypsum Palace.*—Buckley's Scrub Tank, parish Kilfera, county Manara. Situated about 9 miles north-west of Gypsum Palace.

Gypsite has been reported as occurring as low ridges in the vicinity of Buckley's Scrub Tank, extending northerly in disconnected outcrops to the Wilcannia-road, a distance of about 1 mile.

(3) *Wentworth District.*

The Wentworth district embraces the south-western portion of the State, and includes portions of the Murray and Darling Rivers. A number of gypsum deposits occur within this area, but, owing to their isolated position, are at present only of local value. The irrigation settlements at Curlwaa and Pomona require limited quantities of gypsite for agricultural purposes, but otherwise the demand for gypsum is almost negligible.

The following are among the more important deposits of the district :—

Pomona.—Anabranch of the Darling, parish Neilpo, county Wentworth.

Isolated patches of gypsite and clay beds containing nodules of crystalline gypsum outcrop along either bank of the Darling River Anabranch, extending from its junction with the Murray to a point about 12 miles northerly.

On the eastern side of the Anabranch is a wide, low, sandy ridge, with considerable quantities of travertine, running parallel to the stream. Gypsite and nodular gypsum are exposed on both the east and west sides of the ridge. Natural sections show a few feet of gypsite or sandy loam overlying beds of clay through which nodules of crystalline gypsum are scattered. The greatest thickness exposed of the clay bed carrying gypsum is 10 feet, but it may possibly extend to greater depths.

The gypsite is continually being removed by local residents for agricultural purposes, the usual practice being to take the material to a depth of about 18 inches.

The most prominent of the gypsum exposures occur at —

(1) Close to the east bank of the Anabranch, 3 miles above its junction with the Murray.

(2) Reserve 255.—Close to the Wentworth–Adelaide road, 5 miles west-north-west of Wentworth.

Here a limited outcrop of gypsite occurs on the western side of a prominent ridge, and possibly extends over a much larger area beneath a thin covering of sand.

Digitized by Google

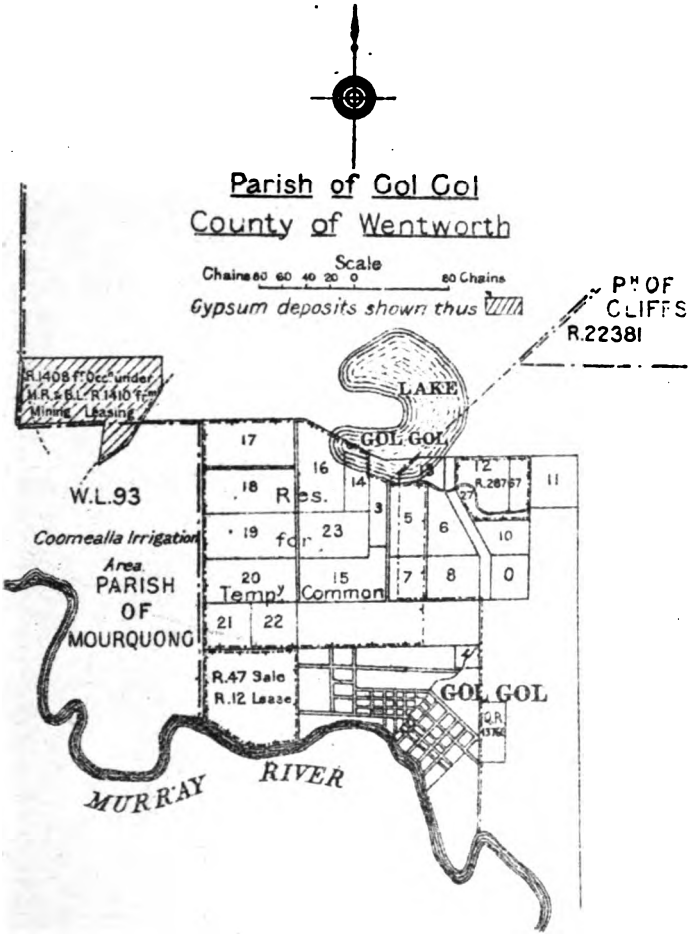
Natural sections on the side of the ridge reveal—

Gypsite	From 1 ft. to 2 ft. 3 in.

Wentworth, Reserve 878, parish Mourquong, county Wentworth. Situated about 15 miles north-east of Wentworth.

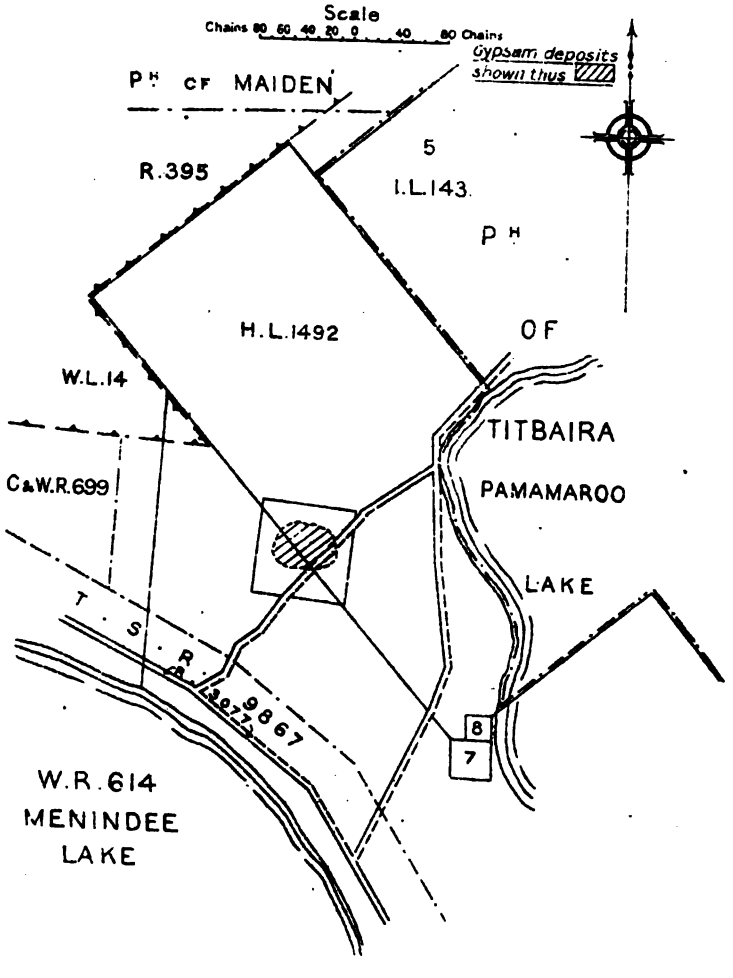
An area of depression some square miles in extent occurs in the northern portion of parish of Mourquong. Throughout this area gypsite outcrops in isolated patches, sometimes forming low ridges which trend approximately north and south. An area of 640 acres, embracing four ridges of gypsite, has been reserved (Res. 878), at the request of the Irrigation Commission and is exempt from leasing under the Mining Act, but apparently there are no

Digitized by Google



Digitized by Google

Parish of Hume
County of Tandora



Digitized by Google

restrictions as to the removal of the gypsite. A considerable quantity of gypsite has already been won from here by neighbouring settlers who require the material for agricultural purposes.

The gypsite ranges up to 3 ft. 6 in. in thickness, but below 2 feet the quality becomes much poorer and is associated with travertine. Undoubtedly a considerable tonnage is available in this deposit, but much more prospecting work is needed before any reliable estimate can be formed of the actual tonnage available.

A number of average samples obtained from here yielded on analyses the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, northern end	62·78	...	1·70	17·32	79·39	36·92
Do eastern end	71·62	...	0·70	8·02	90·57	42·12
Do central portion	72·81	1·64	0·38	4·94	92·08	42·92
Do southern end	68·11	2·67	1·42	8·34	86·13	40·06

The gypsite is of very fair grade, eminently suitable for agricultural purposes, also for Portland cement and for the manufacture of certain plasters.

Gol Gol.—Reserve 722, parish Gol Gol, county Wentworth. An extensive outcrop of gypsite occurs about 4½ miles north-west of the village of Gol Gol. Though cloaked in places by a thin covering of sand, the gypsite for the most part forms low ridges rising about 12 feet above the level of the plain.

A considerable quantity of material has been won from here for agricultural purposes, the excavations show the gypsite to range from 3 to 5 feet in thickness.

Average samples yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	NaCl.	Equivalent Gypsum content.	SO_3.
Reserve 722, eastern end	70·46	0·28	6·10	...	89·14	41·54
Do central portion	65·63	0·32	6·28	6·42	83·00	38·62
Do northerly end	75·26	0·32	3·64	...	95·18	44·26

A large tonnage of high-grade gypsite is to be had here, but further provings are necessary before a reliable estimate of the quantity available could be furnished.

Brooke's Lake.—Situated 4 miles east of the Darling and 20 miles north of Wentworth.

Extensive deposits of gypsite are reported to occur in the vicinity of Brooke's Lake.

Amoskeag.—Between Amoskeag and Nulla Nulla, county Tara, about 50 miles north-west of Wentworth, are a series of salt lakes, around which deposits of gypsite and nodular crystalline gypsum are reported to occur.

Digitized by Google

Lake Paramarook, 13 miles north of Amoskeag.

Extensive deposits of gypsite, estimated to cover many acres, are reported to occur.

Lake Victoria, parish Victoria, county Tara. Situated 32 miles west of Wentworth.

Gypsite, associated with nodular crystalline gypsum, is reported to occur on the margin of a series of small salt lakes, about 3 to 4 miles north-east of Lake Victoria.

Menindee.—H.L. 1492. Situated about 9 miles north-north-west of Menindee.

An outcrop of gypsite occurs on H.L. 1,492, about 2 miles north of the Menindee–Broken Hill road. The deposit lies between Pamanaroo and Menindee Lakes, and is estimated to cover about 320 acres, though the outcrop is not continuous over the whole of this area, being masked in places with sand. No prospecting work has yet been carried out on this deposit.

Euston.—T.S.R. 362, parish Paringi, county Wentworth.

A limited exposure of gypsite, associated with travertine, occurs close to the Gol Gol–Euston road on T.S.R. 362, about 35 miles west of Euston, and half a mile north of the Murray River.

(4) *Balranald District.*

The Balranald district includes portions of the Murrumbidgee and Murray Rivers, and though a number of gypsum deposits are known to occur within this area, their distance from central markets ,and the consequent high freight charges, are such that it is doubtful whether these deposits will ever be worked to any extent for other than local agricultural requirements.

Balranald.—Reserve 1,424, and portion 14, parish Kingi, and portion 63, parish Balranald, county Caira. Situated about 3 miles west of Balranald.

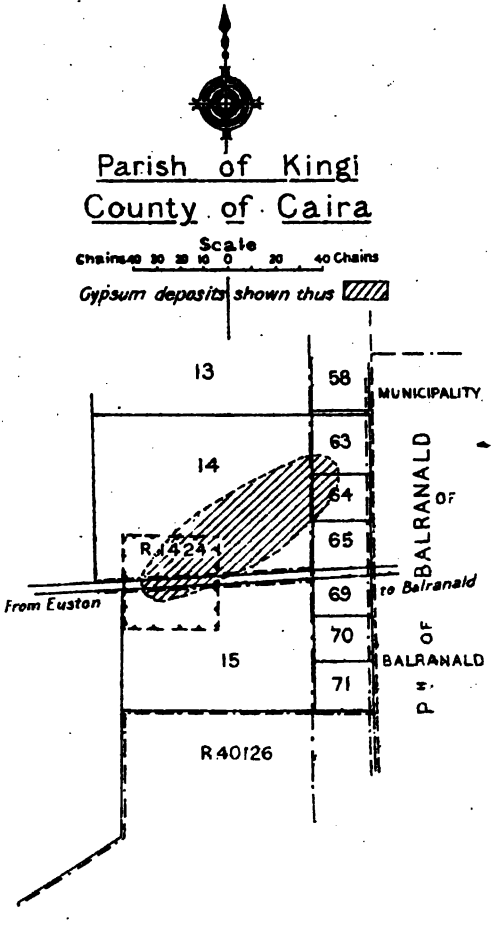
A limited exposure of gypsite occurs on the Euston road, about 3 miles west of Balranald, and is traceable in disconnected patches through portion 14 parish Kingi, into portion 63, parish Balranald, a total distance of 60 chains The outcrop is largely masked with sand, and until further prospecting work has been done the extent of the deposit cannot be defined.

Many years ago shallow shafts were sunk in the gypsite outcropping in, portion 63, and though these workings have collapsed and it was not possible to examine sections, the presence of small nodules of crystalline gypsum scattered through the old dumps would indicate the occurrence of a clay bed with nodules of gypsum beneath the superficial gypsite.

A reserve of 320 acres, covering the greater portion of the gypsite deposit and exempt from operations under the Mining Act, was created at the request of the Water Conservation and Irrigation Commission, who are desirous of conserving the gypsum for the use of irrigation settlers.

Shallow holes sunk when taking samples showed the gypsite to range from 12 inches to 2 ft. 3 in. in thickness, but no particulars are available regarding the thickness of the underlying gypsiferous clay bed.

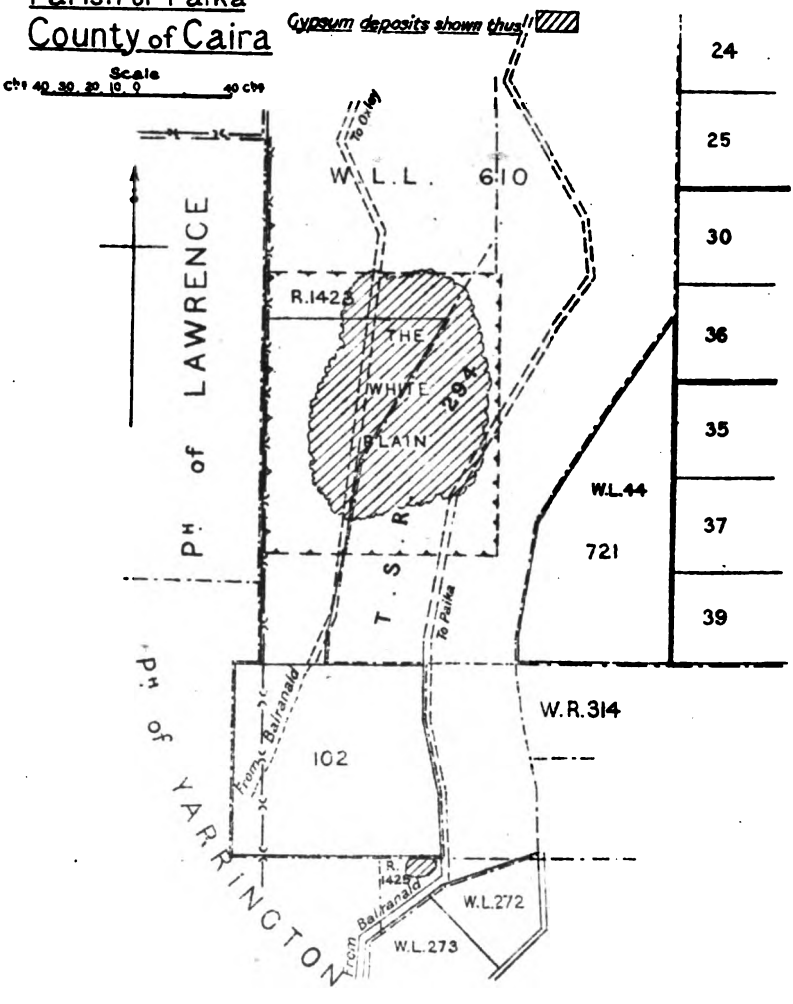
Digitized by Google



Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google

Average samples obtained from here yielded on analyses the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Reserve 1,424, south side of road, 1 ft. 6 in	68·29	4·57	0·70	7·66	86·36	40·15
Portion 14, parish Kingi, nodular gypsum	69·28	trace.	1·80	9·41	87·60	40·74
Portion 63, parish Balranald, 2 ft. section	64·32	2·15	0·92	12·24	81·34	37·82

Balranald.—Reserve 1,425, parish Yarrington, county Caira. A small outcrop of gypsite occurs close to the Balranald–Hay road, 5 miles north of Balranald. Though the exposure is only a limited one it is very likely that the gypsite will be found to extend over a much larger area beneath a mantling of sand.

This deposit is protected by a reserve exempt from operations under the Mining Act.

The gypsite is rather poor in quality, having a good deal of sand admixed with it, and ranges from 10 inches to 1 ft. 6 in. in thickness.

An average sample yielded on analysis :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Reserve 1,425, Gypsite, 1 ft. 3 in. section	52·70	9·81	2·68	16·90	66·65	30·99

Balranald.—Reserve 1,423, parish Yarrington, county Caira. An extensive deposit of gypsite occurs on the White Plain, close to the Balranald–Hay road, about 7½ miles north of Balranald.

The White Plain is an area of depression approximately 1½ mile long by 1 mile wide, and is characterised by isolated outcrops of gypsite and travertine. In places the gypsite is contaminated with sand and clayey particles, but high-grade material also occurs. Until this deposit is systematically prospected and opened up no estimate can be furnished of the quantity available.

A few shallow holes showed the thickness of the deposit to range from a few inches to over 2 feet.

This deposit is also protected by a reserve exempting it from operations under the Mining Act.

Average samples of the better-grade material from here yielded on analyses the following results :—

Description.	$CaSO_4$.	$CaCO_3$.	Fe_2O_3 and Al_2O_3.	$MgCO_3$.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite, White Plains	72·04	0·41	0·32	0·42	7·32	91·10	42·36
Do do	68·90	1·60	0·72	0·59	8·80	87·13	40·52

Digitized by Google

Balranald.—Parish of Bidura West, county Taila. An extensive deposit of gypsite has been reported to occur 35 miles north-west of Balranald, just north of T.S.R. 14,756, and 2 miles east of the 9-mile peg on western boundary of Bidura Station.

(5) *Miscellaneous Localities.*

Bourke—Darling and Bogan Rivers.—Earthy gypsum, associated with travertine and superficial clays, occurs in several places along the Bogan and Darling Rivers. A typical sample of the better-grade gypsum from one of these deposits a few miles from Bourke yielded on analysis the following result :—

	per cent.
H_2O	21·31
CaO	31·28
BaO	.....
SrO	minute trace.
MgO	trace.
SiO_2	3·34
$Fe_2O_3 + Al_2O_3$	1·36
SO_3	42·86
CO_2	·03
	100·18

No chlorides or phosphates detected. There is not sufficient SO_3 present to combine with all the CaO, leaving 28 per cent. of the latter probably combining with silica as silicate.

Bourke.—Parish Fort Bourke, county Gunderbooka. Gypsite outcrops on the eastern side of an area of depression, close to the Wanaaring-Bourke road, 19 miles west of Bourke and 2 miles west of Paka Tank.

The gypsite occupies an area of about 20 acres, but may possibly extend much further beneath a covering of sand. The thickness of the deposit ranges from 7 inches to about 2 ft. 6 in.

Small nodules of crystalline gypsum are to be found in the excavation heaps round most of the tanks in this neighbourhood. An average sample of the gypsite yielded on analysis :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Gypsite	63·28	1·89	14·41	89·03	37·21

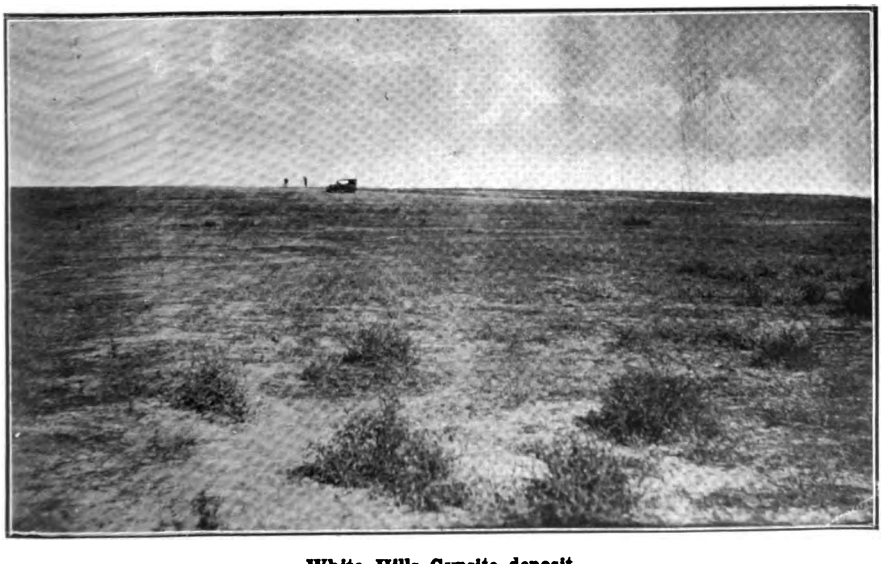
Bourke.—Lake Tank—T.L. 93, parish Greig, county Gunderbooka. Situated about 22 miles north of Bourke.

In the embankment surrounding Lake Tank, close to the Enngonia-Bourke road, are a number of irregular-shaped nodules of crystalline gypsum.

Digitized by Google

To face page 38.

Gypsite, Bellpargerie.



White Hills Gypsite deposit.

Digitized by Google

Digitized by Google

No particulars are available regarding the thickness of the clay bed in which the nodules occur. A picked sample of the crystalline gypsum from here was analysed with the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum, Lake Tank	75·66	0·60	2·90	95·68	44·50

Broken Hill.—Yanco Glen, parish Waukeroo, county Yancowinna. Situated about 22 miles north-east of Broken Hill.

Superficial deposits of gypsum occur at Yanco Glen, and were reported to have been worked in 1904 and 1905 for the manufacture of sulphuric acid required in the salt cake process at the Broken Hill Proprietary Mine, when the acid flotation process was first introduced for the concentration of metallic ores.

Broken Hill.—C. W. Marsh* records the occurrence of gypsum in the Broken Hill lode, and G. W. Card,† Curator, Mining Museum, has described the occurrence of masses of selenite associated with galena and zinc blende in a vugh at the 725-foot level in the South Mine at Broken Hill. These occurrences are of no commercial value.

Cobar.—Reserve 634, parish Mullimut, county Robinson. Situated about 9½ miles north of Cobar.

Crystals of gypsum occur sparingly in the embankment surrounding a private tank on Reserve 634, about 1 mile west of the Cobar–Bourke road. A few shallow shafts sunk in the vicinity of the tank reveal at a depth of 5 feet a clay bed ranging up to 6 feet in thickness through which flakes of gypsum occur.

It is doubtful whether a commercial product can be produced here.

Cockburn, parish Thackaringa, county Yancowinna. Mr. E. J. Kenny, Field Assistant, records the occurrence of nodular crystalline gypsum in the vicinity of Thackaringa homestead. A small shaft, 2½ miles south of the homestead, was sunk on the gypsum and a small quantity of the mineral won.

Culgoa, parish Darling, county Culgoa. Small superficial deposits of gypsite have been reported to occur in parish Darling, about 18 miles south of the Queensland border and 50 miles north-west of Brewarrina.

Dubbo.—A small deposit of crystalline gypsum occurs about 3 miles south-east of Dubbo. A picked sample from here yielded on analysis the following result :—

Description.	$CaSO_4$.	$CaCO_3$.	$MgCO_3$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum ...	70·88	0·23	0·91	2·44	4·60	89·61	41·69

This deposit is too small to be of any commercial value.

* C. W. Marsh, Journ. R. Soc. N.S. Wales, xxiv, p. 127. † Rec. Geol. Survey N.S. Wales, viii, pt. 4, p. 274.

Digitized by Google

Geurie.—Occasional crystals of gypsum are found associated with superficial clays in the vicinity of Geurie. A typical sample of the gypsum yielded on analysis :—

	per cent.
CaO	32·85
SO_3	45·63
H_2O	20·66
CO_2	0·69
Gangue	0·17
Fe_2O_3 and Al_2O_3	absent.
	100·00

No deposits of commercial importance have been recorded.

Grafton.—Small crystals of gypsum have been reported as occurring near South Grafton. A sample sent for analysis yielded :—

Description.	$CaSO_4$.	Al_2O_3. and Fe_2O_3.	MgO.	Gangue.	Equivalent Gypsum content.	SO_3.
Crystalline gypsum	75·94	0·84	0·16	2·90	96·04	44·66

Gulgong, parish Stubbo, county Bligh. Situated about 7½ miles north of Gulgong.

Shafts sunk close to the junction of granite and limestone near the southern boundary of portion 91, parish Stubbo, reveal narrow irregular veins of gypsum, which have resulted from the action of sulphuric acid formed by the decomposition of iron pyrites dissolving the calcium carbonate of the limestone and reprecipitating it as calcium sulphate.

The deposit is too small to be of commercial value. Samples obtained from here yielded on analyses the following results :—

Description.	$CaSO_4$.	Al_2O_3. and Fe_2O_3	Gangue.	Equivalent Gypsum content.	SO_3.
7 miles north of Gulgong, crystalline gypsum	60·16	6·82	11·20	76·08	35·38

Lake Burkanoko and Lake Nichebulka, parish Wanga, county Barrona. Situated 40 miles east of Wanaaring, and 80 miles west-north-west of Bourke.

Extensive deposits of gypsite are reported to occur in the vicinity of Lakes Nichebulka and Burkanoko.

Leadville.—M.L. 44, parish Talbragar, county Bligh. Thin films of impure gypsum occur in the old workings of the Leadville mines.

A sample yielded on analysis :—

	Per cent.
CaO	32·60
SO_3	31·48
H_2O	16·70
CO_2	8·70
Gangue	7·39
Fe_2O_3 and Al_2O_3	2·49
MgO + BaO	0·66
	100·00

Digitized by Google

Meryula, portion 1, parish Rochford, county Robinson. Situated 5 miles south of Meryula railway siding. Gypsum crystals are scattered abundantly through the embankment clay surrounding Meryula Tank, close to the homestead. The gypsum is too sparsely distributed to be of economic importance.

Milparinka, parish Orr, county Evelyn. W. H. Slee*, late Chief Inspector of Mines, recorded the occurrence of gypsum associated with precious opal at Milparinka.

Miowera, portions 24, 71 and 25, parish Kungerbil, C.R. 44,789, and portion 32, parish Mungeribar, county Oxley. Situated close to the railway line at Miowera, about 9 miles east-south-east of Nyngan.

On the southern side of Belar Creek, close to Miowera siding, is an extensive tract of low-lying gilgai country extending north-westerly from portion 32, parish Mungeribar, through C.R. 44,789, across the railway line, and then through portions 25, 71 and 24 of parish Kungerbil to Belar Creek, a distance of about 3½ miles. A belt of this area, from 5 to 20 chains in width, is characterised by a growth of low scrub and salt bush, the soil is pale yellowish to white in colour, and occasionally a small crystal flake of gypsum is seen.

Shallow holes sunk on the ridges separating the gilgai holes expose at a depth of a few inches "seed" gypsum scattered irregularly through a dark brown clay. The thickness of the gypsiferous clay, so far tested, ranges from 1 ft. to 3 ft. 6 in. The crystal fragments (seed) range in size from tiny flakes to irregular-shaped nodules ¾ inch in diameter, though fragments pea-size predominate.

Not sufficient prospecting work has been done to show whether the gypsum-bearing clay is continuous over the whole area, but any of the more whitish ridges disclose the gypsum at a few inches from the surface. Average samples of the gypsiferous clay bed and one of the cleaned gypsum yielded on analyses the following results :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Seed gypsum with clay section, 2 ft. 9 in., portion 32, parish Mungeribar.....	...	...	...	12·62	...
Seed gypsum with clay, section 3 ft. 6 in., portion 25, parish Kungerbil	...	...	...	15·20	...
Clean seed gypsum, portion 25, parish Kungerbil	69·32	...	...	87·67	40 77

The gypsum as it occurs is too impure for commercial uses, and it would have to be cleaned before marketing. The associated clay adheres closely to the crystals, and as these are of varying sizes ordinary screening would hardly prove commercially effective.

Though the cost of mining would be very little, it is very doubtful, unless some cheap method of cleaning can be devised, whether the deposit could be successfully exploited.

A large tonnage is undoubtedly available here.

Mount Brown, parish Orr, county Evelyn. Situated 8 miles south-west of Milparinka.

Professor A. Liversidge† records the occurrence of gypsum at Mount Brown.

Mount Scott.—M.L. 23, parish Talbragar, county Bligh.

G. W. Card‡ records the occurrence of gypsum at Mount Scott.

* Ann. Rept. Dept. Mines, 1895, p. 83.
† A. Liversidge, "Minerals of N.S. Wales."
‡ "Rec. Geol Survey N.S. Wales," viii, pt. 3, p. 258.

Digitized by Google

Paroo River.—Superficial deposits of gypsum associated with travertine occur in several places along the banks of the Paroo River.

The great distance of these deposits from market will retard indefinitely their exploitation.

Trangie, portion 3, parish Gin Gin, and portion 5, parish Weemabah, county Narromine. Situated 12 miles north-east of Trangie.

A narrow band of spongy crystalline gypsum is exposed in the clay bank of the Macquarie River in portion 3, parish Gin Gin, and a similar occurrence is to be seen a little higher up the river in portion 5, parish Weemabah. In each case the gypsum outcrop can be traced for a length of about 100 feet, and the thickness of the beds ranges from 4 to 8 inches. Owing to the presence of sand and clay in the cavities of the gypsum the quality is very poor. Average samples yielded on analyses :—

Description.	$CaSO_4$.	Fe_2O_3 and Al_2O_3.	Gangue.	Equivalent Gypsum content.	SO_3.
Spongy gypsum, portion 3, parish Gin Gin	49·64	7·52	33·88	51·39	23·90
Spongy gypsum, portion 5, parish Weemabah	51·81	5·56	24·88	65·52	30·47

These deposits are too small to be of commercial value.

Wanaaring.—Gleena Tank, portion 3, parish Kulkyne, county Barrona. Situated 25 miles south-east of Wanaaring.

Nodules of crystalline gypsum occur in the embankment surrounding Gleena Tank, and occasional outcrops of gypsite have been reported as occurring on the margins of an extensive swamp west of the Tank.

White Cliffs, parish Kirk, county Yungnulgra. Gypsum associated with travertine has been reported to occur above the opal-bearing rocks (Cretaceous) of this district.

A typical section on the opal fields being—

Red Clay	up to 14 feet.
Gypsum	,, 6 ,,
Hard Sandstone	,, 2 ,,
Opal-bearing Rock	....

Windeyer.—A sample of gypsum, stated to have come from Windeyer analysed in the Departmental Laboratory, yielded :—

		per cent.
05/5,165—	SiO_2	11·18
,,	Al_2O_3	10·26
,,	CaO	24·15
,,	MgO	9·23
,,	SO_3	33·06
,,	P_2O_5	trace.
,,	H_2O	20·10
		99·73

Yantabulla, parish Darling, county Irara. Gypsum has been reported as occurring about 5 miles west of Yantabulla, and 70 miles north-west of Bourke.

Digitized by Google

INDEX.

PAGE.

Alabaster ... 8, 12
Anderson, Dr. C. ... 6
Anhydrite ... 9, 11
Amoskeag ... 35
Auburn ... 14
Australian Gypsum, Ltd. ... 14, 23

Balranald ... 6, 17, 18, 36–38
Beilpagerie ... 7, 31
Belar Creek ... 41
Bidura Station ... 38
Bilbie ... 21, 29
Bonuna Tank ... 21, 31
Boundary Dam ... 21, 29
Bourke ... 38, 42
Brewarrina ... 39
Broken Hill ... 5, 6, 39
Brooke's Lake ... 35
Buckley's Scrub Tank ... 33

Calcined Gypsum ... 13, 14
Canoble ... 21, 27, 28, 29
Card, G. W. ... 6, 39, 41
Carne, J. E. ... 6, 20
Cement Plaster ... 13
Cobar ... 39
Cockburn ... 39
Condobolin ... 5, 7
Culgoa ... 39
Curlwaa ... 33

Darling River ... 33
" " Anabranch ... 33
Doolitty Swamp ... 7, 16, 18
Dubbo ... 39

Euston ... 36

Flooring Plaster ... 13
Flux ... 12
Four-Mile Tank ... 25

German Tank ... 31
Geurie ... 40
Gleena Tank ... 42
Gol Gol ... 17, 35
Goolgowi ... 7, 16, 18, 20
Grafton ... 40
Gulgong ... 40
Gunbar ... 20
Gypsite ... 8, 9, 17
" excavation of ... 9, 18
" occurrence of ... 17
" origin of ... 10, 11, 17

Digitized by Google

PAGE.

Gypsum analyses 16, 17, 19–42
„ composition 8
„ crystalline 16
„ earthy 8
„ imports 15
„ industry 14
„ occurrence 6, 10, 16–42
„ origin 10, 11, 16
„ output 14
„ physical properties 8
„ seed 8, 9
„ specific gravity 8
„ uses of 14
„ varieties 8
„ Palace 6, 32, 33
„ „ Inn 6
„ plasters 13

Hard Finish Plasters 13
Hillman's Tank 20, 21
Hillston 18
Honeycomb... ... ... 14, 22, 23

Insecticides 12
Ivanhoe 6, 29, 30, 31, 32

Kenny, E. J. 39
Kilfera 21
King's Well 21, 28
Kopi... ... ... 11, 17

Lake Burkanoka 40
„ Nichebulka 40
„ Paramarook 36
„ Tank 38, 39
„ Victoria 36
Leadville 40
Liversidge, Prof. A. 6, 41

Macquarie River 42
Marlow 17, 25–27
Marsh, C. W. 39
Maybah Tank 21–28
Menindee 36
Meryula 41
Milparinka 41
Mintiney 21, 24
Miowera 41
Modelling 14
Moore Tank 32, 33
Mourquong 34
Mount Brown 41
Mount Manara 6
Mount Scott 41
Murringobunni 25
Murrumbidgee Irrigation Area 6, 7, 12, 18

Digitized by Google

PAGE.

Narromine 42
Nintie 23
Ninty Tank... 25
Nodular Crystalline Gypsum 9, 11, 16
Nulla Nulla 35
Nyngan 41
Paka Tank 38
Pamanaroo 36
Papatoitoi 23
Paroo River 42
Patterson Tank 25
Plaster of Paris 5, 9, 13
Pomona 33
Portland Cement Manufacture 11
Prince's Lake 31
Rock Gypsum 5, 8, 9
Satin Spar 8, 9
Seed Gypsum 8
Selenite 8, 9
Sculpture 12
Slee, W. H. 41
Spongy Gypsum 17, 23, 25
Spring Deposits 10
Strontianite... 27
Sulphuric Acid 6, 13
Sulphur Trioxide 11
Sylvanham 20
Terra Alba 13
The White Plains 37
Tiarri 21, 24, 25
Ticehurst 29
Tickatoe 21
Trangie 42
Trickett, O. 6
Trida 5, 7, 14, 17, 21–25
Trida—Ivanhoe district 18, 21
Umalee 30
Waiko 28
Wanaaring 42
Water Conservation and Irrigation Commission 7, 19, 34, 36
Waverley Tank 21, 28
Wee Elwah 21, 22
Wentworth 6, 18, 33–36
Western Gypsum Company 7, 14, 22
White Cliffs... 42
White Hills 21, 29
White Plains 37
Wilkinson, C. S. 6
Windeyer 42
Yanco 12
Yanco Glen 6, 39
Yantabulla 42
Yeltie 7, 29

[8 lithos. and 6 pages of half-tone blocks.]

Digitized by Google

SYDNEY:
ALFRED JAMES KENT, GOVERNMENT PRINTER
1925.

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, Government Geologist.

MINERAL RESOURCES
No. 34.

A CONTRIBUTION TO THE

MINERALOGY

OF

NEW SOUTH WALES.

BY

GEORGE SMITH,
Late Inspector of Mines, N.S.W.

Issued under the direction of the Hon. J. M. Baddeley,
Minister for Mines.

SYDNEY: ALFRED JAMES KENT, GOVERNMENT PRINTER.

1926.

1 68101—A [3s. 3d.]

Digitized by Google

Science Library

TN
122
.N421
A3
no. 34

Digitized by Google

LETTER OF TRANSMITTAL.

Geological Survey,
Department of Mines,
Sydney, 12th January, 1926.

Sir,

I have the honour to submit, for publication, Mineral Resources, No. 34, "A Contribution to the Mineralogy of New South Wales, by Mr. George Smith, late Inspector of Mines in New South Wales.

Special attention has been devoted to the mineral deposits of the Western, the Central Western, the Plateau, and the Coastal areas. The method of mineral classification employed by Dana has been followed by Mr. Smith.

The publication should be of special interest and value to mineralogists and mining geologists generally, because it deals, not only with the descriptive mineralogy of the principal occurrences within the State, but also with the natural groupings or associations of the minerals themselves. Mr. Smith, as a Manager, and later as a Government Inspector of Mines, had exceptional opportunities for examining these mineral deposits, some of the more remarkable of which are no longer accessible, inasmuch as they have been destroyed by ordinary mining operations.

Yours faithfully,
E. C. ANDREWS,
Government Geologist.

The Under Secretary for Mines.

Digitized by Google

Digitized by Google

CONTENTS.

PAGE.

INTRODUCTION 5

PART I.

DESCRIPTIVE MINERALOGY—

(*a*) Native Elements 9

(*b*) Binary Compounds—Sulphides, Arsenides, &c. 15

(*c*) Ternary Compounds—Sulpharsenites, Sulphantimonites and Sulphobismuthites 32

(*d*) Chlorides, Bromides, Iodides and Fluorides 37

(*e*) Oxides 43

(*f*) Silicates 62

(*g*) Phosphates, Arsenates and Antimonates 79

(*h*) Tungstates, Molybdates and Vanadates 83

(*i*) Sulphates and Tellurates 89

(*j*) Carbonates 93

PART II.

1. MINERALOGY OF THE BROKEN HILL LODE—

(*a*) Characteristics 104

(*b*) Sequence 105

(*c*) Identification 110

(*d*) Occurrence of Garnet 111

(*e*) Re-deposition 113

2. MINERALOGY OF THE A.B.H. CONSOLS LODE 117

APPENDIX I.—The Occurrence of Cassiterite 121

,, II.— ,, ,, Molybdenite 128

,, III.— ,, ,, Wolframite 132

,, IV.—Mines of the Barrier Ranges (with map) 137

INDEX 139

Digitized by Google

Digitized by Google

LIST OF PLATES.

PLATES.		PAGE
1.—Fig. 1.	Native Bismuth—A. E. Cooper's Mine, Deepwater	9
2.	,, ,, Block 40, Kingsgate	
2.—Fig. 1.	Native Copper—Proprietary Mine, Broken Hill	10
3.—Fig. 1.	,, ,, Cadia Mine, Broken Hill	11
4.—Fig. 1.	Gold—Cumbandry, Gulgong	12
2.	,, Joe's Gully, Tooloom	
5.—Fig. 1.	Native Silver—Aust. B. H. Consols Mine, Broken Hill	14
2.	,, after Embolite—Proprietary Mine ,,	
6.—Fig. 1.	Antimonite—Eleanora and Freehold Mines, Hillgrove	15
7.—Figs. 1 and 2.	Dyscrasite—Aust. B. H. Consols Mine, Broken Hill	22
8.—Fig. 1.	Molybdenite—Water Cut, Kingsgate	28
2.	,, Allies Mine, Deepwater	
9.—Fig. 1.	,, Road Shaft, Kingsgate	29
10.—Fig. 1.	Embolite—Proprietary Mine, Broken Hill	39
2.	Cerargyrite—Aust. B. H. Consols Mine, Broken Hill	
11.—Fig. 1.	Cassiterite on Granite—Tingha	43
2.	,, ,, Greisen—Glen Eden	
12.—Fig. 1.	,, Tingha	44
2.	,, Elsmore	
13.—Fig. 1.	Quartz—Conrad Mine, Howell	56
14.—Fig. 1.	Calcite—A. E. Cooper's Mine, Deepwater	58
2.	Quartz (Japanese twin)—The Gulf	
15.—Fig. 1.	Quartz (etched)—Hart's Mine, Torrington	60
2.	Rutile in Quartz (grass-stone)—Tingha	
16.—Fig. 1.	Native Bismuth—Kingsgate	62
2.	Australite—Tingha and Uralla	
3.	Native Bismuth in Quartz—Kingsgate	
17.—Fig. 1.	Beryl—Heffernan's Mine, Torrington	63
18.—Fig. 1.	,, in native Bismuth—Bismuth Mine, Torrington	65
2.	,, —The Gulf	
19.—Fig. 1.	Chabasite—Reidy's Shaft, Emmaville	66
20.—Fig 1.	Spessartite—Block 14 Mine, Broken Hill	69
2	,, in Galena—Junction North Mine, Broken Hill	
21.—Fig. 1.	Topaz—Oban and Torrington	76
22.—Fig. 1.	Pyromorphite—North Mine, Broken Hill	82
2.	,, Mount Stewart Mine, Leadville	
23.—Fig. 1.	Ferberite—Torrington	84
24.—Fig. 1.	"Ribbon" Scheelite—Hillgrove	88
25.—Figs. 1 and 3.	Stolzite—Proprietary Mine, Broken Hill	89
26.—Fig. 1.	Magnetite—Lionsville	90
2.	Galena on Anglesite—Potter's Mine, Condobolin	
3.	Cassiterite in Granite—Barnett's Mine, Tingha	
27.—Fig. 1.	Calamine on Psilomelane—Proprietary Mine, Broken Hill	95
28.—Fig. 1.	,, ,, ,, ,, ,,	96
29.—Fig. 1.	Calcite, var. Iceland Spar—Lionsville	97
30.—Fig. 1.	Cerussite on Quartz—Silent Grove, Torrington	98
2.	Anglesite on Cerussite—Central Mine, Broken Hill	
31.—Fig. 1.	Siderite—Aust. B. H. Consols Mine, Broken Hill	103
2.	,, Mount Stewart Mine, Leadville	
32.—Fig. 1.	—Map of the Barrier District	138

Digitized by Google

Digitized by Google

LIST OF TEXT FIGURES.

		PAGE
Fig. 1—Scheelite—Occurrence of,	Damifino Mine, Hillgrove	88
Fig. 2—Cassiterite ,,	Pat and Battersby's Mine, Tingha	121
Fig. 3— ,, ,,	Elliot Mine, Torrington	122
Fig. 4— ,, ,,	Cook's Vein, Stannum	123
Fig. 5— ,, ,,	Smith and Wilson's Mine, Tingha	124
Fig. 6— ,, ,,	Pipe near Tingha	125
Fig. 7— ,, ,,	Kennedy and Woolley's Mine, Tingha	125
Fig. 8—Wolfram (Ferberite) ,,	Rockvale Mine, Torrington	133
Fig. 9— ,, ,, ,,	Wild Kate Mine, Torrington	134

Digitized by Google

Digitized by Google

INTRODUCTION.

In 1888 the "Minerals of New South Wales, &c.," by Professor Liversidge was published, since when no publication devoted to descriptive mineralogy has been issued in this State. "The Mineral Resources of New South Wales," by E. F. Pittman, A.R.S.M., then Government Geologist, was published in 1901. The former, a comprehensive work, antedated the opening of the Broken Hill and other important ore deposits, and is therefore necessarily incomplete. Mr. Pittman's "Resources," as its name implies, is more a record of the economics of minerals than purely a work on mineralogy, and is valued as a work of reference.

Many other publications have been issued from time to time by this Department describing various deposits, in which the more prominent minerals were referred to. These, however, have been more in the nature of geological or economic, rather than mineralogical records, and in no case has more than a passing reference been made to the mineralogy of the deposits. This contribution therefore, it is hoped, may supply some of the details which are lacking in the previous publications.

The chapter upon the mineralogy of the Broken Hill lode is to show the variations of the oxidised zone, though they were not uniform in depth throughout its length, and to describe some of its beautiful mineral occurrences. Many of the minerals existed only in certain parts of the lode, the upper portion of which was the most interesting, but even in cerussite, the commonest of the minerals, there were distinct differences by which it could be recognised with considerable accuracy as belonging to the shallow, intermediate, or lower portions of the zone.

The great amount of alteration to which both the Broken Hill and Consols lodes had been subjected was shown differently in each. In the former the oxidised zone was complete in its rearrangement, while in the latter the changes visible at the respective levels though distinct were less complete. These changes varied from deposits which

Digitized by Google

near the surface had been altered or replaced almost beyond recognition, to bodies of unaltered dyscrasite which were believed to be original deposits, though they were contained in the oxidised zone some short distance above the water-level.

The Consols lode is specially dealt with to describe its mineral occurrences and also to refer more fully to silver sulphides which, though occurring in the unaltered zone, are regarded as being the result of redeposition of material derived from the leaching of deposits of dyscrasite, which were rather common in the shallow stopes. These sulphides would thus appear to have been deposited from descending solutions, though found at some distance below the water-level. For the purpose of comparison with them somewhat analogous occurrences observed in mines outside of the Broken Hill field have been referred to. Special interest is attached to these minerals, and the object in referring to them particularly is to describe the evidence surrounding them, which in each instance seems to point to their secondary origin. Certain authorities appear to be still somewhat in doubt as to the nature of similar occurrences, and as they may not have had opportunities of inspecting such deposits under equally favourable conditions as the Writer, he has dealt with them rather fully.

Minerals have from time to time been recorded as occurring in New South Wales with which the Writer has no acquaintance, and therefore none of them have been included in this book. It may be doubted whether the discovery of some of them could be verified. Those that have been described herein could be added to, however, and the record of localities considerably enlarged. It is hoped the information now presented may be used as a foundation upon which a more complete work devoted to mineralogy may be constructed.

The chapters upon cassiterite, molybdenite, and wolframite, are included with the object of describing more fully the mode of occurrence of these minerals than is usual in works upon mineralogy. To render this more complete a list of the various minerals found in the same deposits is included in each case. It is not suggested that the lists are complete, but they are as complete as the close observation

Digitized by Google

of the Writer for thirteen years could make them. No mineral is included that was not actually seen by the Writer in association with the principal mineral.

In some instances analyses are given without reference to the analyst; these were made in the laboratories of Broken Hill, and all were unofficial. They represent but a small fraction of the determinations that were made in connection with the minerals of that field.

The text figures were roughly sketched in the mines referred to upon the dates stated on them.

The arrangement of the minerals into groups is substantially the same as that used by Professor J. D. Dana in his great work, "A System of Mineralogy."

The information set out in this book has been gathered from personal acquaintance with the deposits and minerals to which reference has been made. As already stated, it is not claimed that the list of minerals embraces all the varieties known to occur in New South Wales. The commission with which the Writer has been entrusted is to describe those minerals which have come under his personal observation in this State during the past thirty-seven years, which, with the exception of two or three years spent in Queensland, is the period covered by these notes.

For some years, dating from the early part of 1888, as ore buyer and assayer on the Barrier Ranges field representing an English smelting company, the Writer was afforded the opportunity of inspecting the ore deposits of all the mines on that field, and at that time there were many (about 100), in active operation in such centres as Broken Hill, Purnamoota, Day Dream, Apollyon Valley, Mount Gipps, Umberumberka, Thackaringa, &c. Later, as mine manager at Broken Hill, he was privileged to visit the workings of the large mines whenever anything of a specially interesting mineralogical character was met with, and of gathering any minerals he desired. Subsequently as Inspector of Mines for twenty-one years, it became his duty to inspect the most interesting mineral occurrences in the State. In each case his observations continued over a period of

Digitized by Google

several years, so that it was possible for him to follow the gradual unfolding of many of the ore bodies as the work of developing them proceeded.

These exceptional advantages were possessed by no other person interested in the subject. They permitted, under very favourable conditions, the investigation of many interesting mineral occurrences that now belong to past history, and of which there is no record. They will never be repeated; further important discoveries may be made in the future, but no two mining fields present quite the same features.

This is the Writer's warrant for undertaking to describe these deposits and minerals as he saw them. Many of his descriptions are of the minerals as they appeared *in situ*, and in such cases his references apply to them in mass rather than as individuals.

In conclusion, the Writer desires to express his cordial thanks to Mr. E. C. Andrews, B.A., Government Geologist, for kindly co-operation. To Mr. G. W. Card, A.R.S.M., Curator and Mineralogist, for ever-ready friendly assistance. To Messrs. J. C. H. Mingaye, F.I.C., H. P. White, F.I.C., W. A. Greig, and W. G. Stone, for various analytical results. To Dr. C. Anderson, M.A., for determining many of the crystal forms, and Mr. T. H. Smith for investigating several doubtful minerals.

Digitized by Google

Digitized by Google

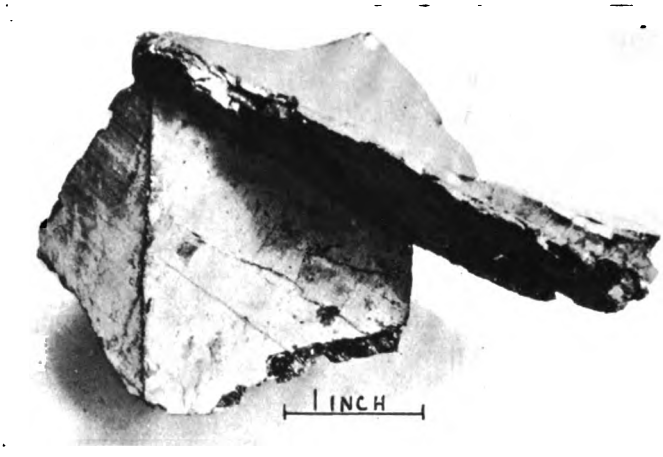


Fig. 1.—Native Bismuth, Cooper's Mine, Deepwater.

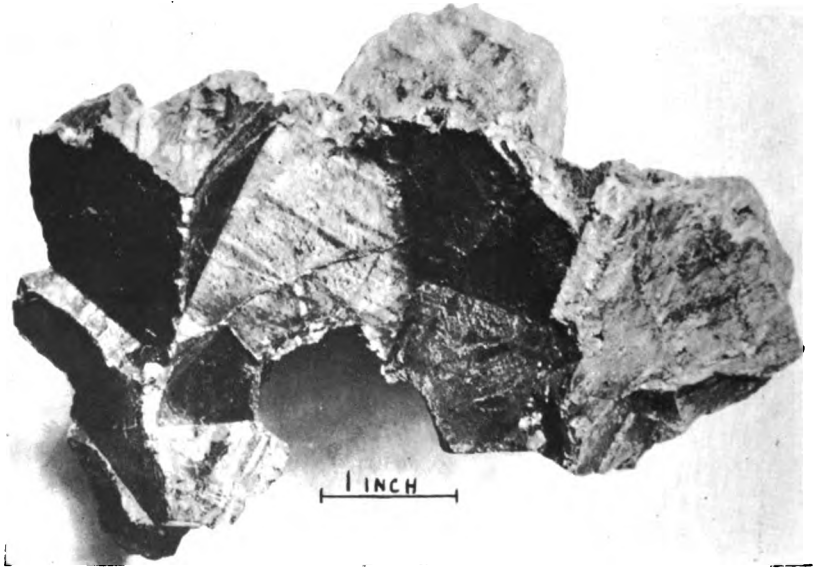


Fig. 2.—Native Bismuth, Block 40, Kingsgate.

Digitized by Google

PART I.

DESCRIPTIVE MINERALOGY.

(*a*) NATIVE ELEMENTS.

Antimony (Sb).

In small crystalline tin-white bunches antimony was met with in calcite in the Consols mine (Broken Hill). Only one deposit was seen associated with antimonite in the upper portion of the siderite zone. The locality in which these minerals were found was in the vicinity of several rare minerals which also occurred only in this part of the mine.

A similar deposit was found in the Reform mine (Lucknow) at a depth of 450 feet, also enclosed in calcite, but without any other associated mineral except gold, of which it was estimated to contain from 7 to 24 ozs. per ton. The antimony was in small fragments penetrating along the cleavage planes of the calcite; in the Consols deposits it was enclosed in the calcite at its junction with siderite. In each case the occurrence was of limited extent.

Arsenic (As).

Native arsenic was found in small irregularly shaped pieces in auriferous quartz veins in several parts of the Drake district. Also more massive at Lunatic in the same locality, some portions being in mammillated layers.

It occupied the centre of a rich gold-bearing quartz vein two miles north of Forbes. In this, though the mineral was somewhat bunchy in places, it formed a continuous vein for some distance a quarter to half an inch thick. The quartz associated with it was very rich, the gold being free; the arsenic however, contained 4–5 ozs. per ton. It was all of massive type. The mineral generally was dark steel grey, and tarnished very readily to a darker grey or black.

Bismuth (Bi).

Native bismuth is by far the most important of the bismuth minerals it forms the bulk of the output of this metal, and in quantity must exceed that of all the other ores combined many times over. It is found as small nuggets to large lumps; a few years ago an assortment could be seen at Kingsgate of many large pieces each weighing, probably, from 15 to 30 lb. They were all amorphous with a cast of the quartz crystals they had been deposited upon. Practically all the large lumps of bismuth were found seated at the base of these crystals, where they evidently represented a later deposition. Smaller pieces were intermixed with molybdenite, and these too were frequently in contact with similar quartz crystals, though they might be comparatively or even very small. Probably the largest masses seen in the State were from Block 40 (Kingsgate), but other mines in that district, and at Jingera, yielded large lumps. In recent years almost equally fine examples were obtained in Cooper's and the A.W. mines (Deepwater), which had been associated with quartz crystals, though neither of these could be considered a "crystal" pipe in the Kingsgate sense. Similar, but much smaller pieces of native bismuth were found in the Great Cobar mine accompanied by magnetite.

A variety from Block 45 (Kingsgate) consisted of nuggets of this metal enclosed entirely in molybdenite, not as an ordinary associate, but as a deposit upon and around them and conforming to their irregular form. The

Digitized by Google

bismuth was of all shapes, the most common being rounded like a potato and weighing from less than an ounce to several pounds each. There was but one occurrance of this type, but there were many deposits in which there were inclusions of small flat sheets between the leaves of the molybdenite ranging from the thinnest of flakes to sheets a quarter-inch thick, and difficult to separate in the process of concentration of the molybdenite. This form was not uncommon in the Kingsgate pipes, and was also seen in the Allies mine (Deepwater.)

The bismuth itself is probably very pure, though it does not appear to have been analysed; it has, however, been known to assay many ounces of gold and silver. It has been found to contain flakes of bismuth telluride at Kingsgate, Bismuth (Torrington), and Jingera (Whipstick); and at Bismuth crystals of beryl also.

One well-formed hexagonal prism of native bismuth was found in one of the smaller pipes at Kingsgate. The alternate faces of this crystal were obliterated, the prism thus consisting of three sides, with pyramidal termination.

At Kingsgate in several pipes small flakes of bismuth were enclosed in quartz, though rarely in crystals. It also penetrated clear, transparent quartz in Block 40 in filaments; dozens of thread-like wires could be seen in a two inch square, forming one of the most interesting occurrences of this mineral. In tiny flakes it was enclosed in the rich green fluorite which was associated with some of the wolfram deposits of The Gulf (Emmaville).

It was completely or partly changed to the oxide in the upper parts of those pipes which were opened in recent years. The best examples were found in Cooper's and the A.W. mines, in each of which it could be seen in all stages of oxidation from the metallic form in the centre.

Bismuthinite is a common associate of native bismuth in the Kingsgate and Deepwater mines, but the quantity is never great. In the Bismuth mine smaltite was found with coarse granular or crystalline masses of bismuth, of which large quantities were contained in pegmatite, which is referred to in connection with the tungsten ores. This was a totally different and distinct form of matrix compared with the quartz pipes of other localities, though the bismuth itself was not dissimilar, except in shape. At Jingera the proportion of bismuthinite was greater than in any of the Northern mines.

Bismuth ores are frequently associated with molybdenite, but there are many deposits of this mineral which contain no bismuth and *vice versa*. Besides molybdenite, the following minerals are found with native bismuth:—Quartz crystals (common), smaltite, magnetite, pyrite, pyrrhotite, ferberite, beryl, fluorite, biotite, and cassiterite.

Copper (Cu).

This mineral in its occurrence somewhat resembles native silver, but its crystals are more definite; at Broken Hill they were perfect. At Cobar and Mount Hope it was found in thick arborescent, or more delicate dendritic masses and indefinite crystals of octahedral habit, often with cuprite crystals attached to them. Groups of crystalline material which had been formed in rock joints were common, but the crystals were imperfect and generally more or less mixed with the enclosing rock, and, perhaps, partly changed to cuprite. In recent years good crystallised bunches were met with in the C.S.A. mine, but the crystals, of a short, stout type, were rather indistinct

Digitized by Google

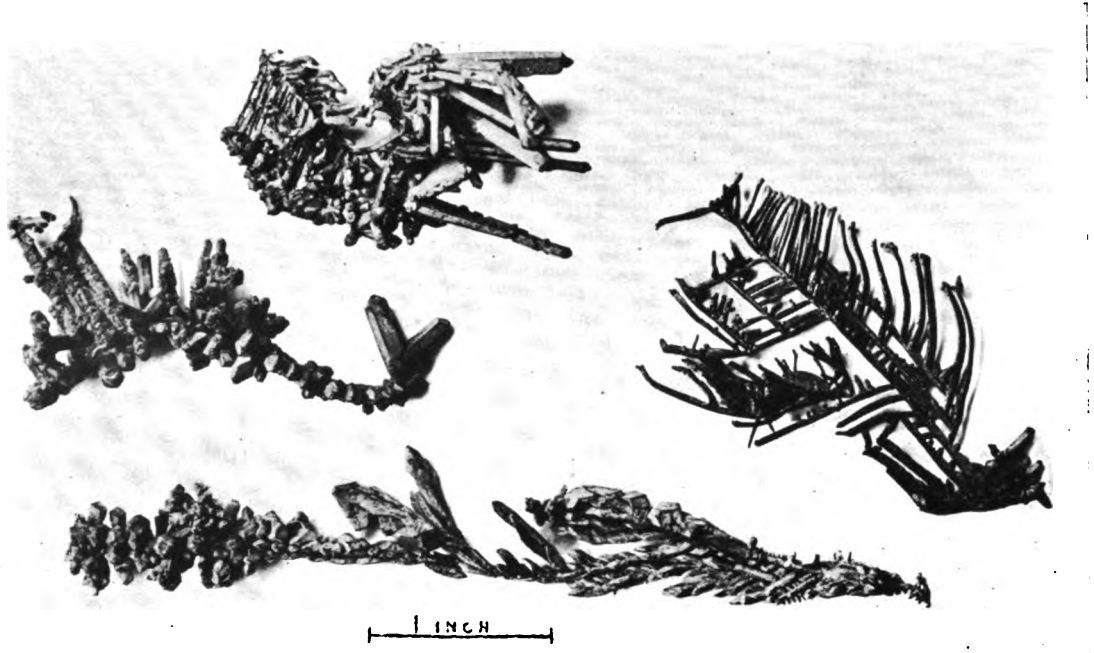
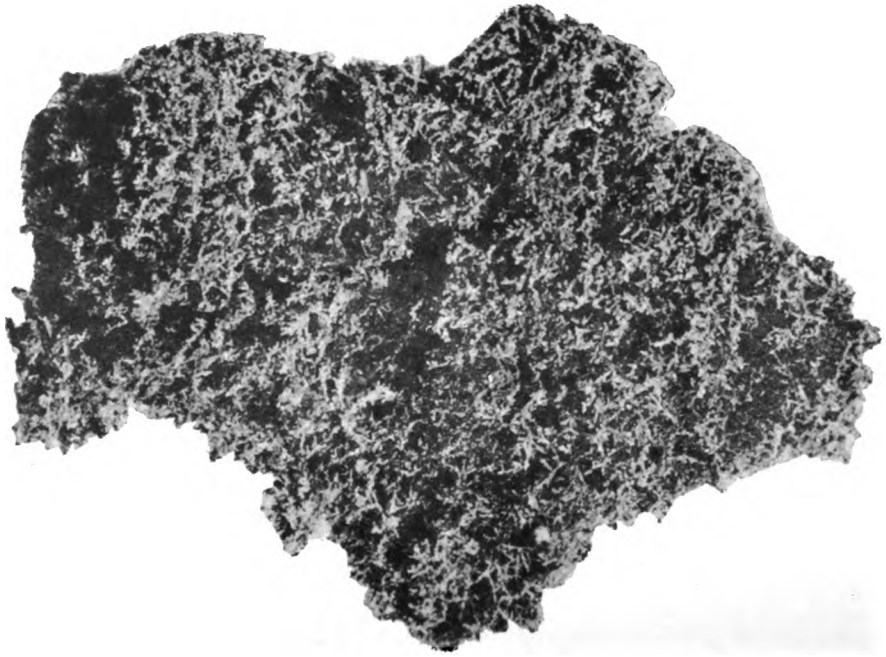


Fig. 1.—Crystallized Native Copper, Proprietary Mine, Broken Hill.

Digitized by Google



Crystallized Native Copper, Cadia Mine, Cadia.

Digitized by Google

in form. Others associated with cerussite were similarly indefinite, but they were of a purer and more highly crystallized type than those found in Cobar so many years before.

In Broken Hill it occurred in vughs, and such occurrences yield the finest crystallisations. Many of the crystals were elongated octahedra, tapering to a point, others of similar form had numbers of hexagonal prisms grown upon them in such quantity and size as to dwarf the original crystals they were formed on, others again at a certain point had started to grow a short and thicker hexagonal prism on the apex of each crystal which had arrested the growth of the four-sided prism they were attached to. These little crystals on the apices were never completed, and further growth at these particular points ceased, as if the failure had discouraged further effort. Many of the four-sided wire-like prisms occur as branches off one stem, all parallel, and each one starting to grow its own hexagonal termination. Some groups were entirely composed of the hexagonal crystals, and these formed the most symmetrical and best developed of all the types; they were due to the elongation of the rhombic-dodecahedron. Very pretty copper-red clusters were found in the Proprietary mine, exceptionally well grouped and more perfect than those seen in the other mines. The finest groups were, however, found in Block 10, as they were surprisingly long, wire-like and straight, with branches radiating in all directions, all beautifully crystallised and much finer than the Proprietary occurrences because they were formed upon a larger scale. These clusters of crystals were impressive in their perfection and beauty and worthy of being classed with the best of the wonderful crystallisations of this lode. There were also large crystalline and much more massive varieties in this mine (Block 10) which were derived from the same source, the rich secondary sulphide ore-body. Similar masses on a smaller scale were, however, seen in several of the mines at Broken Hill, both crystalline and amorphous.

Stalactitic clusters in profusion were found with linarite hanging pendent from the roof of the large vugh of the British mine in 1888. They were partly oxidised and encrusted with other minerals, but being somewhat decomposed, they exhibited no defined crystallisation and were thus much inferior to the unaltered kinds.

Masses of filigree-like forms were seen in the Cadia mine (Cadia), which were interlaced but detached, and could easily be drawn apart into very perfect clusters of delicate dark copper-red crystals.

Among the amorphous and less interesting varieties were masses and sheets in the Broken Hill lode and at Cobar. Thin leaves at Cobar and in the Budgery mine (Hermidale). Plates upon which were small crystals of cuprite found in rock joints at Drake. Small bunches indistinctly crystallised associated with large lead-zinc sulphide deposits at Hall's Peak (Hillgrove). In plates and solid threads in the quartz lode of Dick's mine (Bodangora), and in thin plates in fluorite following the cleavage planes, and thickly impregnating the mass, at The Gulf (Emmaville).

Diamond (C).

The principal diamond mines are at Copeton, in which district the alluvial drifts are distributed over a wide area and at various depths below or above the existing level of the surrounding country, being protected by the basalt covering. The diamonds are not necessarily all contained in the bottom layer of wash, they may be 2 or 3 feet up from the bottom, deposited perhaps by later deposits of drift similar to what is seen in some of the

Digitized by Google

alluvial tin mines. The bedrock is generally free from boulders, but in the Deep Shaft and Mount Ross mines great granite masses were met with which were so large and hard that the levels had to be diverted to avoid them.

In a few places the wash was cemented by iron-oxide forming a conglomerate which enclosed some of the heavier associated minerals, and in this the diamond could be seen firmly embedded.

The stones can be readily picked out from the concentrates when they are wet owing to their superior lustre, but there are other lustrous minerals like topaz and another rather angular colourless stone which is always small and has not yet been identified. Very perfect crystals were often seen; the octahedron, with its modifications, was frequently found among the very brilliant yellow varieties. The stones average about 3 or 4 to the carat, and are graded according to size, the price depending, except in the case of unusually fine stones, upon the number of stones to the carat, the greater the number the lower the price. The yellow tints are the commonest and the most lustrous in their rough state. The clear white are the most valued, but many of these contained tiny inclusions or showed some other defect. The largest and finest seen by the Writer from this locality was a colourless octahedron weighing possibly over 2 carats, but its value was greatly reduced owing to a small black spot in the centre.

Boarts were met with, but were not very plentiful, and there seemed to be no demand for them.

Several diamonds were found in tin-sluicing operations in parts of Cope's Creek, near Tingha, and particularly in the tributary known as Darby's Branch, which is close to the township. These localities are all within 3 miles of the town; beyond that they did not seem to exist, and in this respect they resembled the sapphire in its occurrence on this field.

Diamonds are occasionally found at Howell in similar tin-bearing wash; also in the bed of the Macquarie River, near Mumbil, where they were obtained in gold dredging. The largest crystal seen by the Writer was an octahedron from the deep alluvial leads of Gulgong. It was fully a quarter-inch across.

The colours varied from colourless to straw-yellow, rarely brownish, and very light green.

Associated minerals were cassiterite, tourmaline, sapphire, topaz, zircon, garnet, jasper, and pleonaste. At Howell wood-tin was sometimes found also.

Gold (Au).

Gold is so widely distributed that it is proposed to refer only to some of the occurrences which by reason of their form or association seem to be more than usually interesting.

The most perfect crystallisations were found at Joe's Gully, near Tooloom, in a small seam of crushed andesite, the gold occurring in the rock at the junction of two joints. Only 3 ozs. were obtained, but all was beautifully crystallised. One group comprised several inter-crystallised cubes, the largest of which was slightly under half an inch across its largest diameter. All the cubes showed hollow faces with sharp angles and edges.

Crystallisations were not uncommon in the alluvium at Cumbandry (Gulgong), the octahedron being the basic form. There appeared to be no single crystals and the aggregates showed many modifications of this type, but the angles were much rounded through attrition.

Digitized by Google

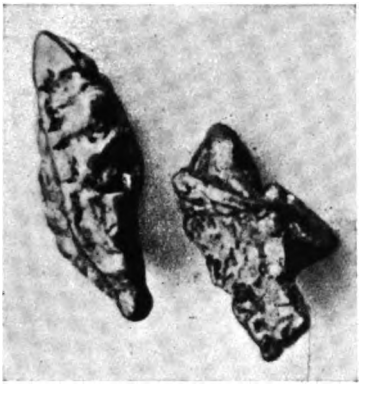


Fig. 1.—Cumbandry, Culgong.

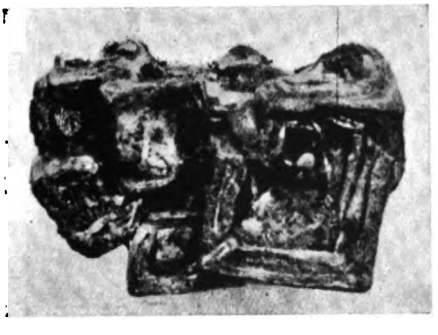


Fig. 2.—Joe's Gully Tooloom.

GOLD CRYSTALS.

Digitized by Google

Digitized by Google

A few fine but small crystallised groups were found in a large quartz formation near Euchareena. Others less perfect were seen at Hargraves, Long Creek, and Yambulla. Small, but almost perfect cubes, were obtained at Kookabookra. At Lionsville delicate arborescent forms were associated with cinnabar in a quartz vein, but they were almost hidden by a coating of limonite.

Among the uncrystallised varieties the richest patches were seen at Forbes, associated with native arsenic; in the Goldsworth (Uralla) and the Myall's United mine (McPhail), all of which were enclosed in quartz. Like most rich deposits they were of limited extent. Interesting impregnations were contained in felsite at Pambula, in serpentine at Gundagai, in slate at Cobar, Canbelego, and McPhail, and also at Parkes in unusually large pieces. In these practically all the gold was in the cleavages or slickensided joints of the rock.

Other matrices were:—Limonite pseudomorphous after pyrites, in very coarse fragments, at Caloola Creek (Newbridge); tourmaline, at Mundoe (Ashford–Bonshaw); malachite, in small but solid veins, at Gulgong; antimonite, in nests entirely enclosed by this mineral, at Hillgrove; calcite, at Lucknow and Cadia (Lucknow Consols mine), in which the gold was coarse and could sometimes be seen to have followed the cleavage planes of the calcite; mispickel, at Lucknow, in which the gold was not always visible, though plentiful enough to ooze out on being roasted.

Two rounded water-worn slate boulders were found during dredging operations at Mongarlowe (Braidwood), which were freely encrusted with coarse particles of gold. They were lying on the bedrock under an overburden of 15 or 20 feet of alluvium. The gold was loosely attached and had obviously been deposited upon them while in the position in which they were found. They therefore represented a late deposition.

Mercury (Hg).

Mercury was seen in small globules, with cinnabar, in the Broadwater mine (Ewengar, Clarence River). The occurrence of this mineral was rare, and the quantity very limited.

Platinum (Pt).

Platinum occurs with gold in a deep alluvial lead at Platina (Fifield), which has been worked for many years and proved for a length of over a mile. Both metals are found in much water-worn coarse grains and nuggets. Small rounded boulders of hard ferruginous conglomerate have been seen containing nuggets of both metals and bearing evidence of much attrition. They had possibly been derived from conglomerate which shows on the surface some distance away, and is by many of the miners regarded as the source of the metals; the real source is, however, unknown.

Silver (Ag).

Silver is a widely disseminated mineral of much diversity of form, often met with in crystalline masses of great beauty, but rarely in definite crystals. It occurs as frostings, films and plates with galena, as films in garnet sandstone, in capillary nests and frostings in mispickel, as scales and small crystals in vughy quartz, as a powder or as fine or coarse crystalline crusts on calamine and in similar form with tiny filaments in cerussite, as flakes and irregularly-shaped pieces in schist, as shot-like inclusions in native copper, as

Digitized by Google

films and plates in kaolin, as crystallised wires with crystals of argentite, and upon various oxidised copper ores. In small flakes, films and arborescent groups or in solid masses in and upon limonite, also in reticulated forms in siderite and crystalline wires and arborescent groups in calcite.

The largest deposits were seen in Broken Hill, and the finest individual occurrence in the Consols mine, in which masses of loose wire-like crystals were found which had been originally embedded in calcite, but on its dissolution had been released. These crystals were often thick and solid, but did not exceed 2 inches in length, they were well formed, but not definite in their angles. They were often striated, and resembled strands of parallel thread, the terminations being irregular and ragged as if there had been parallel growth of certain bunches of the thread which formed a crystal. A few had thrown off branches from the main stem, none were straight, many were doubled back upon themselves, even the thickest were sometimes bent near the termination in such manner as to suggest that much force had been used upon them. The bending, however, did not occur after the crystals were formed, but was part of their natural growth in which there is a constant tendency to assume a curly form. This is characteristic of this form of native silver as may be seen in widely separated localities; it was well shown in the Tulloch mine (Armidale), in which small bunches of wires were seen in vughs in calcite closely curled upon themselves, though there was ample room for their extension. It was notable that the solutions which had removed the gangue had had no effect upon the silver; it was not even tarnished. The particular deposit described above was the only one of its kind found in the Consols mine, and its crystals were distinctly different from any others met with. It yielded several hundredweights of pure silver.

In the same vicinity other similar deposits remained in calcite which had not been altered. The silver was in arborescent groups, bright, pure, and perfect in every respect but crystallisation. There were tree-like growths consisting of radiating branches from a single stem; at the ends of the branches traces of octahedral forms might be seen as if an unsuccessful attempt had been made to form definite crystals. This type was so enclosed in the calcite that it was not always visible until the mass was crushed, then the most beautiful of delicate arborescent forms could be seen in tangled masses from which the pulverised calcite could be shaken. Both varieties were equally pure, the assay value ranging from 97·2 to 99·6 per cent.

Though the Consols mine yielded the largest single deposits of native silver, the production in the aggregate of the Broken Hill lode was infinitely greater. Very fine arborescent groups from the Proprietary mine were enclosed in limonite boulders generally surrounded by a yellow limonitic powder. It also formed films in limonite and kaolin, accompanied by silver salts from which it had been partly changed, or, perhaps, thick flakes of appreciable size, not confined to any particular mine. As a gray powder and thick coarsely crystallised deposits, it was found in large quantity in the Junction mine in a vughy section which was lined with calamine ($ZnCO_3$) crystals. Where leaching had taken place, the calamine was decomposed, and the effect upon the silver was to change it from the bright crystalline into a gray and more powder-like form. In the Junction North mine, it was found in films filling joints in garnet sandstone. In the North mine, cerussite was impregnated with it, much resembling what was seen in later years in the C.S.A. at Cobar.

In films and frostings it was of common occurrence at Umberumberka, and in plates and small crystalline patches at Yerranderie, both occurrences

Digitized by Google

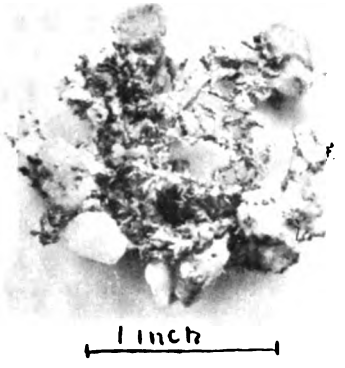


Fig. 1.—Native Silver, Aust. B. H. Consols Mine.

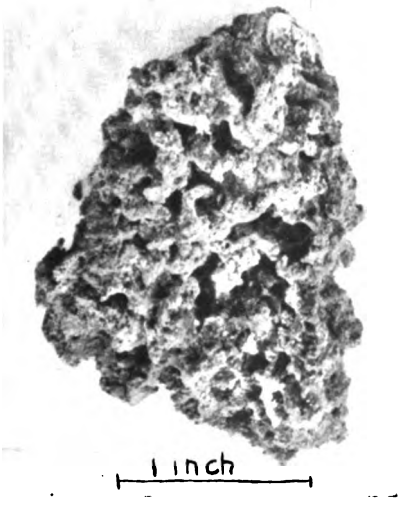


Fig. 2.—Native Silver after Embolite, Proprietary Mine, Broken Hill.

Digitized by Google

Fig. 1.—Crystals of Antimonite, Eleanora and Freehold Mines, Hillgrove.

Digitized by Google

being associated with galena. In small pieces it was found with cerargyrite in limonite in the Maybell mine (Mount Gipps), and in the same gangue it formed veins, plates, and solid masses in considerable quantity in the New Year mine (Apollyon Valley). It occurred in small crystalline deposits with iodyrite in the East Consols mine (Broken Hill) and as scales in similar siliceous gangue in the Conrad lode (Howell). Frostings, films, and small plates with nests of capillary or wire-like crystals, some through tarnish resembling gold, in calcite or directly upon mispickel, were met with in the Tulloch mine.

Among the more uncommon occurrences were ragged lumps of native copper containing silver in the form of pellets like large shot, but invisible until the mass was cut through. These were found in the Proprietary mine; and though so intimately associated, the metals were quite distinct from each other. In the same mine very fine coralloidal native silver was obtained which was pseudomorphous after embolite. An occurrence in rock was seen in the Eaglehawk mine (near Broken Hill) in which an impregnated schist contained plates and scales of this metal.

Sulphur (S).

Sulphur was seen in the upper levels of the Consols mine (Broken Hill) in small rounded crystals on the edges of clusters of cerussite crystals, or upon the crystals themselves, in vughs in limonite. It was also found as spongy masses upon galena, from which in each case it had been derived.

(*b*) BINARY COMPOUNDS.

Sulphides, Arsenides, etc.

Antimonite (Sb_2S_3).

Fine crystallisations of antimonite found in the gold-mines at Hillgrove were unusually interesting, because of their perfection of form and the peculiar distortions of many of them. The larger groups from the Freehold mine were composed of bunches of long columnar crystals, much intergrown, and radiating masses, all of which were much striated. Single crystals were not uncommon, some with a length over twenty times their diameter; among the shorter and stouter of these there were many distortions. Both large and small frequently showed crystal terminations, but most of them having reached across the openings containing them were terminated in irregular forms. The distorted crystals were bent, or even crinkled, into fantastic shapes, the bending in some cases being at right-angles to the original direction of the crystal. There were also solid groups of which single crystals could be seen with a definite bend, or perhaps shattered, but still forming a compact portion of the same group.

The distortions seemed to be due to two causes. In the first case, the crystals having had the natural progress of their growth interrupted through meeting an obstacle, had continued growing, and longitudinal expansion was then only possible by bending. The second cause was due to crowding. As each crystal extended, crowding was ultimately inevitable where the spaces were restricted. In some instances the growth of one crystal against the apex of another had had a crushing effect upon the weaker one. This resembled very closely the effects of crushing upon the timbers in the Baker's Creek mine, where very thick hardwood stulls had been driven into themselves through earth movements which had brought the walls of the lode closer together. The gradual compression had eventually caused some of the

Digitized by Google

timbers to crush in the middle. The crystals grow in straight lines under normal conditions, but as they broaden and lengthen the space they are in may become too small to admit of further expansion, and the weaker are then forced from their normal position. This could be seen in the radiating groups, where crowding through growth at the base had gradually pushed the outside crystals from their direct course, and so caused them to bend and spread out at the free end, where there was room for it.

Very similar conditions were seen in the Eleanora mine, in which the crinkling was even more pronounced, though some of the accompanying crystals were perfectly straight, with pyramidal terminations. The evidence supplied by them seemed to be the same as that explained above, but there were fewer of the crystals, and the deposits offered a less favourable field for investigation. Molybdenite was seen in similar distorted forms, apparently due to similar causes, as described elsewhere.

Other interesting forms seen in this mine were acicular crystals, interspersed with quartz crystals, over both of which flat rhombohedra of siderite had been deposited. The quartz was evidently the first arrival, and the apices of some of its crystals penetrated the siderite, which was the latest. They formed a very pretty and interesting combination. The most delicate of capillary crystals, like bunches of fine hair, were also found deposited on small quartz crystals, much resembling the occurrence of bismuthinite at Glen Eden (Glen Innes).

In the Baker's Creek mine there were also many good crystallisations consisting of stout groups, and capillary types laid together like rope and composed of delicate hairs. The latter had commenced to oxidise to cervantite, and displayed the iridescent colours sometimes seen upon metallic sulphides.

Groups of well-formed crystals, with quartz crystals, and resembling some of the Hillgrove occurrences, were found at Taylor's Arm. At Broken Hill small radiating patches much mixed with native antimony were met with in the Consols mine, forming small deposits between calcite and siderite.

Of the massive type, quantities were seen in the Cosmopolitan mine (Hillgrove), and in several other mines in that district, particularly at Metz, which were worked for this mineral. Gold, sometimes visible, was present in more or less quantity; in the Eleanora mine it formed little patches, which were enclosed entirely in the antimonite. It was often found in the scheelite veins, intimately associated with the scheelite. At Gresford it occurs as a small lode, which has been proved for some distance. In the Broadwater mine (Ewengar) it was met with in small bunches, associated with cinnabar.

Argentite (Ag_2S).

Argentite is recorded as having been found in many parts of the State, but as a definite mineral the writer knows of its occurrence only in the Consols mine (Broken Hill), where it was met with in plates, films and crystals, or, more frequently, as pseudomorphs after dyscrasite and native silver. The crystals were cubical, not always complete, some with the shrivelled appearance characteristic of this mineral, and most perfect where associated with native silver. The pseudomorphs after dyscrasite were perfect in their outlines but were sometimes partly hollow, the spaces containing a little pyrargyrite. Those after native silver were very perfect in form, black and shining. All were sectile and more or less malleable, the usual colour being very dark lead-grey. Assays showed 83·98 and 85·58 per cent. silver, the theoretical value being 87·1 per cent.

Digitized by Google

It was found in the Consols mine replacing galena, and this variety has been described by E. F. Pittman, A.R.S.M.* Analysis showed the composition to be very variable as will be seen by the following results which were obtained by J. C. H. Mingaye (Nos. 1–3) and H. P. White (No. 4). There was only one occurrence of this mineral, and it appeared to be quite homogeneous as it was uniform in its cubical structure.

	No. 1.	No. 2.	No. 3.	No. 4.
Moisture	·08	·44	·14	·50
Ag_2S	77·99	76·62	13·25	10·86
Cu_2S	·62	·32	1·82	2·00
FeS_2	1·42	·45	·42	.....
$PbSO_4$	19·36	19·60	77·60	84·61
PbS	.....	·50	2·20	·96
Insol	·30	1·60	4·50	1·00
	99·77	99·73	99·93	99·93

Bismuthinite (Bi_2S_3).

Is often found with native bismuth in molybdenite pipes, but always in rather limited quantity. It is most frequently seen as radiating fibrous bunches enclosed in quartz, or, it may be, deposited at the base of crystals of that mineral like native bismuth. Very good examples were met with in several of the pipes at Kingsgate and Deepwater. Acicular and capillary crystals are not uncommon lying loose in vughs, with the usual lining of quartz crystals, or occupying small openings in which they form nests of the most delicate crystallisations, Some at Glen Eden (Glen Innes) bore a close resemblance to the capillary antimonite of Hillgrove. Very fine bunches of this capillary variety were found at Kingsgate so fragile that they could be blown away. In a similar deposit were radiating groups of stouter crystals enclosed entirely in transparent quartz.

The radiating acicular type occurred at Deepwater interleaved in molybdenite, a mineral with which all these occurrences were more or less intimately associated. The coarser fibrous kinds were found at Kingsgate, Deepwater, and Jingera (Whipstick) associated with native bismuth and molybdenite, and also at Wunglebong (Tenterfield). The massive variety was seldom seen, and then only in the most limited quantity. The colours varied from light to dark grey.

Blende (ZnS).

Zinc blende is one of the most widely distributed of metallic minerals, though there are many such deposits in which it does not appear to exist. It was not seen by the writer in any molybdenite mine except the Allies (Deepwater) in which a small quantity of the ferriferous variety (marmatite) was met with. The wolfram deposits were free from it, and the only tin-mines in which it was known are the Butler (Torrington) and Ottery (Tent Hill), and in these it is present in very limited quantity.

There are many galena lodes in which it might have been expected to occur, at Thackaringa for instance, but the ores there proved unusually free from such mixtures, the only exception being the Lady Brassey mine, in which galena was associated with pyrites and blende. It was not met with in the Consols mine (Broken Hill) which was so noted for the diversity of its sulphides. It is, however, found in immense quantities in the Broken Hill lode, and in many of the outside mines of the Barrier Ranges.

* Jour. Roy. Soc., N.S.W., 1895, p. 50–51.

Digitized by Google

At Sunny Corner, Rivertree, and elsewhere it occurs in quantity associated with galena and other sulphides. In the Silver Peak mine (Yerranderie), it could be seen replacing the wall rock, and so forming a series of parallel threads and bunches, but the occurrences so far met with upon this field generally seem smaller than might have been expected in this type of lode.

The only crystallised variety was in the Mount Stewart mine (Leadville), and this was of the ferriferous variety, which seems to afford larger cleavages than other types. It is most commonly found in granular bronze-brown to black masses of brilliant lustre, lighter in colour in those varieties in which there is less iron.

It was not seen changed to the sulphate, though this is not a rare occurrence in decomposing sulphide deposits beyond the State, but it occurs as an interesting secondary sulphide in the Central mine (Broken Hill). This ore, which was found to contain 60 per cent. zinc, is white, compact, amorphous, resembling magnesite in appearance and by adhering strongly to the tongue. The unaltered or partly altered original sulphide may sometimes be seen in the centre of the mass. Further discoveries of recent date were covered with masses of secondary plumose galena.

Marmatite (ZnS + FeS in variable proportions).—This, a ferriferous variety of blende, is met with in many localities as the associate of other sulphides, the most common of which are galena and pyrites. Samples analysed from the following mines by J. C. H. Mingaye and W. G. Stone respectively gave the following results :—

	Conrad (Howell).		Mt. Stewart (Leadville).
Zn	51·57	.....	52·88
Fe	14·95	.....	12·67
Pb	.....	.....	·04
Cu	trace	.....	.....
Cd	·30	.....	trace
S	32·98	....	32·19
Insol.	·04	.....	·22
	99·84	.....	98·00

The colour is black, the cleavage perfect, and the lustre adamantine. A particularly lustrous variety was found with molybdenite in the Allies mine (Deepwater). The Mount Stewart occurrence was in crystals which were covered with crystallised dolomite; it was met with lining the walls of vughs.

Bornite ($FeCu_2S_3$).

Bornite is rather a rare mineral of which exceptionally fine large bunches were found enclosed in andesite in the Burley Jackey mine (Woodstock). This occurrence, which was unique in size and purity, yielded considerable quantities of the clean mineral together with much equally pure chalcopyrite with which it was associated. It was amorphous, and of bluish-purple colour, distinct from the more reddish tints of the South Australian and Queensland occurrences of this mineral. In specks it has been seen in several localities, but always in quantities so small that the Woodstock deposits seem the more remarkable by comparison with them. At Tingha, bornite was met with associated with cassiterite in an impregnation in granite.

Chalcocite (Cu_2S).

Chalcocite is a mineral which does not present the interesting features so often seen in the secondary copper ores. It occurred in large masses in the

Digitized by Google

Great Cobar and other Cobar mines, and is commonly found in small veins in the earthy malachite of many mines of the Western district. In the Burley Jackey mine it formed thick solid veins. The lode in the Invincible mine (Silverton) was composed of it, though it had undergone some change to malachite. It is a common mineral, but the quantity is generally limited. In the North mine (Broken Hill) it was seen changed, and partly changed, to covellite.

Only the amorphous variety was met with. In colour it was dark steel-grey to black.

Harrisite.—A pseudomorph of chalcocite after galena, found in the Proprietary mine (Broken Hill). There was but one known occurrence, which was enclosed in a boulder of malachite and cerussite by which it was being replaced. It possesses the steel grey colour and appearance of chalcocite with the cubical structure of galena.

Chalcopyrite ($Cu_2S + Fe_2S_3$).

This, the most abundant of copper minerals, has been found in important quantities in many localities. Masses of the pure ore were associated with bornite in the Burley Jackey mine and large quantities were found in the Great Cobar and other mines of the Western district. Like galena it is, in this State, most interesting mineralogically where the deposits are insignificant; it is to these that the crystallised varieties are apparently confined. The most perfect crystals were seen in the Consols mine (Broken Hill) in which they were rather small, the largest half an inch across, but they were without tarnish and of bright rich gold colour with smooth surface. In their pure condition they are easily broken and these being attached to siderite were too fragile to remove without damage. They occured in vughs, each crystal being generally separate from the others.

Similar crystals were met with in the Conrad mine (Howell) seated at the base of quartz crystals and thus resembling the occurrence of some bismuth minerals in being deposited in the deepest crevices, probably after the crystallisation of the quartz had been completed. This mine was noted for its beautiful groups of quartz crystals, and where the copper mineral was present on such perfectly crystallised material the combination was both interesting and attractive. The crystals were tetrahedral and being partly changed to covellite their blue-black colour formed a pleasing contrast to the transparent crystals they were attached to.

Crystals of chalcopyrite of similar type, also coated with covellite, were seen in crevices in granite with cassiterite in the Elliot mine (Torrington). They were found loose and of the same tetrahedral habit but more wedge shaped. Small bunches of the pure mineral enclosed in mispickel in the Webb's Consols mine (Emmaville) were also partly altered to covellite, but in each case the change did not extend far into the mineral.

At The Gulf (Emmaville) a body of chalcopyrite in the form of a pipe was followed downwards as far as water would permit. This was entirely encased in fluorite, the whole being enclosed in granite.

The richer varieties of this mineral often show the gorgeous colours, due to tarnish, which are characteristic of the mineral, but some of the poorer kinds exhibit as great, or even a greater, range of hues. There is, however, no uniformity; similar ores under the same conditions show varying degrees of alteration, as may be seen by exposing them together to the weather for some weeks.

Digitized by Google

Cinnabar (HgS).

This mineral was found in solid bunches in the Pulganbar mine (Gordon Brook–Clarence River), with some quantity of mercurial tetrahedrite (schwatzite) and other minerals. The lode was large in parts, but the ore-bodies were patchy and small in comparison, though some were of high quality. Perhaps the finest specimens were found in the alluvium as rounded "shode" slugs from which the gangue had been almost or completely removed; they were of all sizes up to 15 lb. in weight.

In the Broadwater mine (Ewengar—in the same district) the cinnabar occurred in thin streaks and bunches through the quartz filling of the lode. In small vughs it was covered with crystalline quartz, the cinnabar having preceded the quartz in these openings and formed their original lining. This could be seen only when the lode material was broken; in section the cinnabar then appeared to be crystallised. It also impregnated the quartz, much of it being associated with crystals and bunches or antimonite. Schwatzite also occurred in this mine, in small fragments generally, each being surrounded by cinnabar. Native mercury, a rare occurrence, was seen in small quantity with the cinnabar.

This mineral was met with in small patches associated with free gold in quartz at Lionsville, but the quantity was unimportant.

All these occurrences were of a deep red colour, characteristic of cinnabar. Associated minerals were schwatzite, antimonite, chalcopyrite, pyrite, limonite, chrysocolla, malachite, azurite, calcite, gold, and quartz. The oxidised copper ores were present in very small quantity.

Alluvial cinnabar, in rounded fragments, apparently very pure, of a cochineal-red colour, was found in the Cudgegong River (Mudgee).

A bright red mercurial sulphide was met with in the Proprietary mine (Broken Hill), frequently more or less intimately mixed with a similar yellow mercury salt, each being closely associated with silver iodide. These mercurial minerals were enclosed in kaolin, in which they formed irregular patches that rapidly tarnished on exposure to sunlight. They were never satisfactorily determined. In their mixed condition they appeared to be mercury sulphide, with an unknown mercury-silver compound, the iodyrite being an associate only, but what the particular chemical combinations really were is not known. It has been suggested that the red variety was cinnabar mechanically mixed with iodyrite, a simple classification that would not accord with the results of early investigations, which showed that there were several varieties containing iodine or chlorine, perhaps both. It would, therefore, be unsafe to generalise from the evidence supplied by any one of them.

A different type consisted of small bright red patches in bluish blebby opaline quartz, between the grains of which were films of iodyrite. This red mineral was a mercury compound which did not tarnish on exposure, and evidently constituted a distinct variety from those that did, but it was not investigated. It was perhaps identical with the mineral described by Professor A. J. Moses (see Tocornalite).

A more definite mercury-silver mineral of bright yellow colour was found as nests of powder in the same mine. This was classified as tocornalite (Ag_1Hg_1, described elsewhere), but whether the yellow mercury silver compound impregnating kaolin, previously referred to, was of this variety is very doubtful.

Digitized by Google

It was a coincidence that almost simultaneously with the finding of these minerals in the Proprietary a similar discovery was made in the Consols mine, the coincidence being greater because of the dissimilarity shown by their respective ores. There were two distinct varieties, one a red coating upon dyscrasite, which slowly tarnished to much darker colour and was probably cinnabar, the other a bright deep red impregnation in hard siliceous limonite, which changed its colour immediately it was exposed to direct sunlight. When protected from all light it retained its colour for some time, but it seemed impossible to prevent it from gradually fading to light brown This mineral was also closely associated with iodyrite, and was never satisfactorily determined; that it was a simple mixture of mercury sulphide with iodyrite seemed improbable. It was perhaps an unrecorded combination of the two compounds. The yellow mercurial mineral was not seen in the Consols mine.

The varieties in kaolin retained their colours only if protected from the light. There are probably many specimens of kaolin from Broken Hill in collections to-day showing a very dark yellow-green or brown discoloration which, if scratched, would reveal the red or yellow mercury-silver mineral, perhaps both, underneath; the tarnish is never more than skin deep.

Cobaltite ($CoS_2 + CoAs_2$)

This mineral occurred in siderite and calcite in the vicinity of some of the rich silver deposits of the Consols mine (Broken Hill), not in contract, but forming separate veins or bunches either above or below them. Native silver was, however, associated with this mineral at lower levels, the two being plentifully distributed through siderite. Some deposits of dyscrasite also were found with or near the cobaltite. The larger bunches were met with at comparatively high levels, but the quantity gradually lessened with depth as the yield of silver grew less. It was found much altered and impregnated with silver; one such deposit very much decomposed occurring in a fault plane where it junctioned with the lode, assayed 3,000 ozs. silver. The unaltered mineral, however, contained little silver; one assay gave 20 ozs.

Smaltite, which resembles cobaltite, was found in the same stopes, but it was darker in colour and only known in the massive form. Cobaltite was seen in good crystals, the common form being the rhombic-dodecahedron, tin-white, and of brillant lustre when freshly separated from the matrix. Some tons were found which, on exposure, oxidised superficially to erythrite

Covellite (CuS).

Covellite is a common mineral which results from the decomposition of chalcopyrite, and more rarely, chalcocite, generally as a black earthy or indigo-blue mineral. Where galena and chalcopyrite occur together, as they frequently do, the first change towards oxidation is generally seen in the penetration of galena by indigo-blue films of covellite along the cleavage planes. This change in an advanced condition was seen in the Broken Hill mines and when complete the result is cuproplumbite. Changing from the crystallised form of chalcopyrite it occurred in the Conrad (Howell) and Elliot mines (Torrington) and from the amorphous variety in the Gobandry (Fifield), Webb's Consols (Emmaville), and other mines. It is common in copper lodes in the partly altered zone which separates the oxidised and sulphide ores and is often erroneously called "black oxide."

It was seen in the North mine (Broken Hill) changed from chalcocite, and impregnating cerussite in the East Consols mine, in each case in earthy form and indigo-blue colour.

Digitized by Google

Dyscrasite (Ag_6Sb and other combinations).

Dyscrasite is a very rare silver mineral which is unrecorded in Australia except in the Consols mine (Broken Hill). It was found in many different proportions of silver and antimony, ranging from Ag_6Sb to $Ag_{15}Sb$. The silver content above Ag_6Sb appeared to increase in multiples of three, and each of such combinations was met with except $Ag_{15}Sb$. These various compounds might be divided into three groups according to differences in form and composition. The first was represented by a variety containing about 72 per cent. silver (Ag_6Sb) and distinguished by its coarse crystalline structure, basal cleavage, and fine prismatic crystals. The larger crystals were generally broken (cleaved) when found, but smaller kinds on being separated from the calcite which generally enclosed them were like a bundle of sticks, each one pointing in a different direction. In section some of the longer crystals exhibited a stellate-like form, but they were rare and never found entire owing to their ready cleavage.

The second variety contained about 84 per cent. silver (Ag_6Sb) and was nearly all of a granular type of which the largest masses were composed. The grains were crystallised, tin-white, and of very brilliant lustre. On breaking these large masses they shewed such little cohesion that portions were shattered into innumerable crystalline fragments and grains.

The third variety was arborescent and resembled native silver but was less malleable. This type contained the highest silver contents.

Although associated with other minerals dyscrasite was never intermixed with them and therefore with so much material available there was no lack of perfectly pure mineral for examination. A large number of tests were made, and in each instance the result showed that the combination of silver and antimony was in definite proportions from which a formula could be readily calculated.

Some very large masses were found which were encased in a thick covering of stromeyerite so that the amount of silver visible in the face of the stope after each blasting was considerable. One mass was estimated *in situ* at 30 cwt. but was certainly larger, being "frozen" on the footwall it had to be blasted off, which broke out the largest middle portion. This was again broken for convenience in handling, and after several large pieces were taken from it the thickest part could not be further reduced in size though explosives were used. This then weighed 16 cwt., by far the largest of its kind ever recorded. A portion still glistened in the face of the stope from which this mass had been broken and other large pieces from it were subsequently obtained. The 16 cwt. piece on shipment measured 33 in. by 27 in. by 19 in.; it was smelted by itself in England and though the actual yield in ounces of silver was not advised, it was known to average about 80 per cent. Its silver contents netted £4,375. *In situ* a slab measured 72 in. by 52 in. by an average thickness of 4 in. Many similar masses of the same variety ranged from 10 cwt. downwards. One isolated piece of 87 lb. containing 83 per cent. silver was found in a vugh whose roof was covered with crystals of siderite. The form of these crystals was faithfully reproduced in the silver which in itself was crystalline. Even after the mass had been hammered and mutilated to free it from the gangue the form of the siderite remained, as may be seen in the photographs of it. As with many of the beautiful and unique minerals of the field there is none of this mineral extant, though it was found in several vughs in similar form. It was unusual to find unaltered dyscrasite in limonite, as in the higher levels it was generally changed to chloro-antimoniate of silver. One large lump however

Digitized by Google

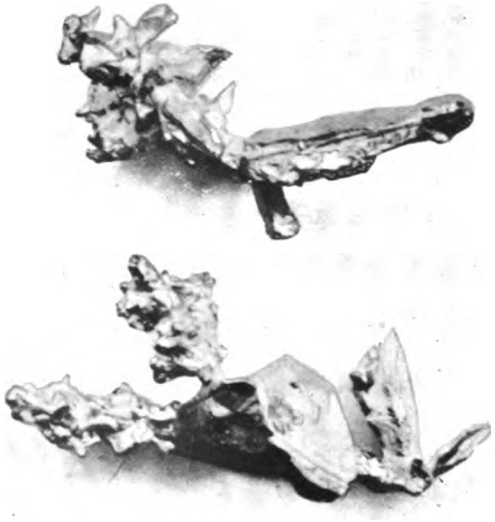


Fig. 1.—Crystals.

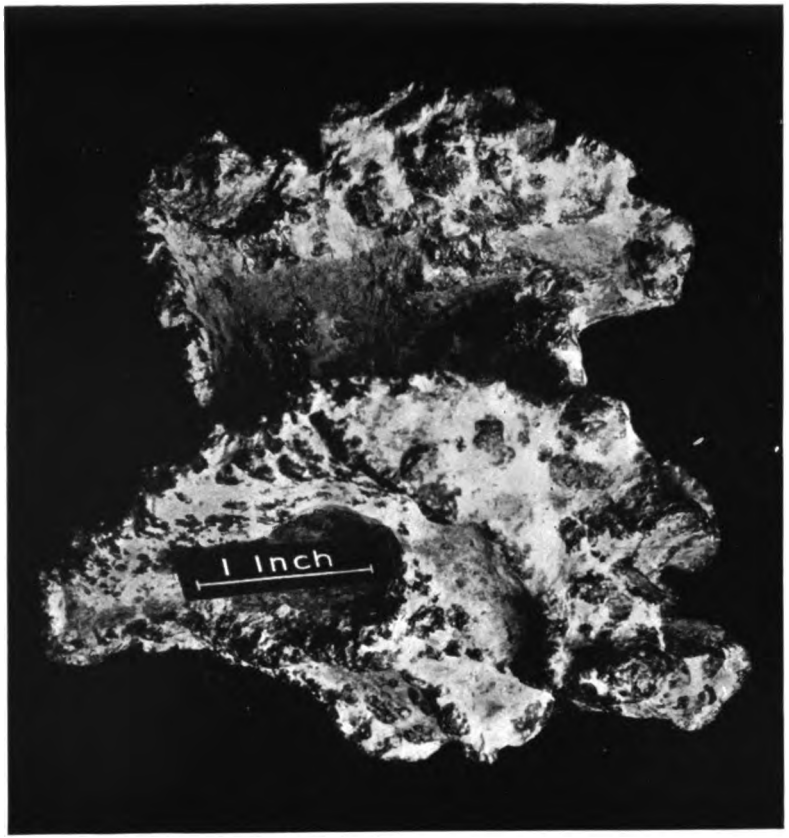


Fig. 2.—Nugget (entire).

DYSCRASITE, AUST. B. H. CONSOLS MINE.

Digitized by Google

Digitized by Google

remained unaltered though enclosed in limonite, and weighed when freed from the gangue 172 lb., its assay value being 80·07 per cent. In this deposit there were a number of much smaller nuggets which were loose in the lode through the dissolution of the calcite which had originally enclosed them. Other similar nuggets had been completely changed to the chloro-antimoniate and were covered with cerargyrite, sometimes in large octahedral crystals. These occurrences, the unaltered and the altered, were found at about the same level but in different chutes, and indicated that the conditions in each section were not the same.

As deeper levels were reached other interesting combinations were met with, the crystals, which formed a large proportion, being unaltered and generally perfect. One small deposit was coated with a bright red material which tarnished to a dark red colour and was probably cinnabar. Another was enclosed in galena, and though there were small solid masses some of it was in the form of delicate needle-like prisms which could not be seen until the crystals were broken. Tetrahedrite also formed an encrustation upon this deposit. Nearly all the crystals were, however, enclosed in calcite and siderite and some beautiful examples were seen, but they were rather indefinite in form. Dr. Anderson, Director of the Australian Museum, has examined some of the crystals, and has kindly supplied the Writer with the following description of them:—

> "The dyscrasite is sometimes in the form of flattened unterminated prismatic crystals embedded in calcite or siderite, strongly striated vertically, and irregularly aggregated into parallel and sub-parallel groups, or it may be in cylindrical crystals, the faces in the prism zone merging into one another, and terminated by the basal plane or by a globular enlargement on the apex. Occasionally the crystals are pseudo-hexagonal plates, tabular on the base, which is marked with strise running parallel to its outlines. One such crystal, about 7 mm. in diameter, was mounted on the goniometer and approximate measurements were obtained; probably the forms c (001), e (011), z (112), s (133) are present, but the angles obtained vary considerably and the forms cannot be identified with certainty. Another habit is represented by a granular mass of very small, closely aggregated, equi-dimensional crystals, which somewhat resemble rhombic dodecahedra in shape, but all the faces are concave and quite unsuitable for goniometric determination."

Ag_3Sb and Ag_6Sb were the two most common varieties, and it is estimated that upwards of 10 tons of the pure mineral were found. There had been a much larger quantity as was shown by the many tons of chloro-antimoniate of silver which had resulted from its alteration, besides other deposits of which little of the original mineral remained.

Silver Chloro-antimoniate (Composition variable).—This mineral was a very important one, though not a definite species. It is included here because it was a secondary ore resulting from the alteration of dyscrasite. It was peculiar to the Consols mine (Broken Hill) in which it was found in large quantity. The change from dyscrasite was sometimes incomplete, and the unaltered mineral could then be seen in the centre. The line of demarcation in these masses was distinct, the outer portion being completely changed, while the inside retained the bright crystalline structure of the original mineral. It was confined to the upper levels, the nearer the surface the greater the alteration; in some cases this had been carried to such an extremity that practically the whole of the silver had been removed, nothing being left but an insoluble oxide of antimony with partial replacement by cerargyrite.

Digitized by Google

Some large boulder-like masses, weighing up to 7 cwt., were encrusted with crystallised secondary cerargyrite, but the most of them were much smaller and generally roughly spherical. Nearly all were associated with cerargyrite, in solid layers over an inch thick upon some deposits, forming very distinctive minerals owing to their respective gray and green colours. Where they had been further changed the alterations were very interesting as a later deposit of chloride of silver had found its way into the centre, while the outer crust was still composed of chloro-antimoniate. Another form contained a core of the more recent chloride which was surrounded by a thick crust of chalcedonic quartz and from some of these the silver had apparently been extracted from the centre after it was enclosed by the silica, the empty space showing evidence of corrosion.

Concentric structure of both the silica and cerargyrite was often well marked around the central core of the latter mineral. Pseudomorphs after the granular variety were frequently seen and more rarely after the prismatic types, but the latter being enclosed in solid limonite and much more readily broken than their gangue, were never found entire. The colour was uniformly light gray, tarnishing on exposure to brown. It was quite sectile. Its specific gravity was found to be 4·9.

The silver value varied considerably. In the earlier discoveries nearer the surface it averaged about 55 per cent., but richer varieties were subsequently met with which considerably raised this average. Typical samples assayed 66·11, 69·47, and 70·20 per cent.

Samples of the mineral were analysed by J.C H. Mingaye and H. P. White, with the following results; these samples, however, were of rather impure material, but they were the best available at the time :—

	No. 1.	No. 2.
Moisture, at 100° C	·56	·13
Combined water	4·04	4·37
Ag	47·46	45·57
Sb	16·87	20·72
Cu	·11	·48
Pb	·62	·31
As	trace	trace
Au	trace	—
CaO	3·78	4·25
MgO	1·17	·20
Fe_2O_3	2·11	·45
Cl	13·69	12·27
Insol.	1·01	·90
O (by dif.)	8·58	10·05
	100·00	100·00

Galena (PbS).

There is a general belief that variations in the structure of galena are indicative of silver values, the finer structure containing the highest silver and lowest lead contents. The following comparison is given to show how impossible it is to estimate the silver by such a method :—

Fine grained variety from	Apollyon Valley,	Silver	5 oz.,	Lead	65	per cent.
,, ,,	Yerranderie	,,	150 oz.	,,	50	,,
Very fine grained variety from	Consols mine	,,	724 oz.	,,	80	,,
Coarse cubical ,,	,, ,,	,,	15 oz.	,,	70	,,
,, ,,	Conrad ,,	,,	150 oz.	,,	69	,,
,, ,,	Consols ,,	,,	1,078 oz.	,,	75	,,
Very coarse cubical ,,	Gipsy Girl mine	,,	80 oz.	,,	80	,,

The best average types of this mineral representative of the two classes were seen at Thackaringa, Howell, and Yerranderie, each of which was found

Digitized by Google

in large quantity. The fine-grained galena of Yerranderie contained over four times as much silver as the cubical variety of Thackaringa which, however, was richer in lead, and typical of the most common kinds, assaying about 35 oz. silver and 60 per cent. lead. Similar ore in the Conrad mine was of equal silver value but richer in lead than that from Yerranderie, rather an important fact, seeing that the Conrad ores have been stated to be too refractory for successful treatment.

Galena, with or without blende, was found in several mines of the Barrier Ranges which were essentially lead as distinguished from silver mines. Also in large bunches in the Conrad mine often free from other sulphides. Large bodies have been exposed at Hall's Peak (Hillgrove) intimately associated with blende and pyrites. In smaller bunches with mispickel and blende in the Webbs-Consols mine (Emmaville) and in many other localities.

A quantity of "shode" galena (some tons) was found just beneath the surface on the Gipsy Boy leases (Thackaringa) encrusted with limestone which had prevented oxidation. It was in the form of rounded nodules not unlike potatoes and had evidently been derived from the disintegration of the lode.

At Silverton it was seen enclosing long fibres of tremolite, but being of low silver value, the deposit was not prospected.

Of the crystallised types, probably the most interesting was the plumose secondary variety of the Broken Hill lode, which was formed in cavities in the sulphide ore-body. A recent discovery in the North mine shows it to be made up of clusters of very small crystals among which the cube is prominent. This particular deposit was associated with a cream-coloured secondary zinc sulphide, which in itself is an equally interesting occurrence. Crystals of galena are rather uncommon; they might be expected to occur in association with the large bodies of clean ore of which there are so many, but the writer has never seen such a connection. They were found in the Consols mine, not in contact with the galena deposits, but as isolated occurrences in vughs upon siderite, quite apart from other ores. In the Junction North mine, not associated with the sulphide ore-bodies, but in isolated crystals in garnet sandstone. In the Gem mine (Apollyon Valley) in vughs in siderite resembling those of the Consols but smaller, and quite separate from deposits of galena which were being mined. In the Conrad mine (Howell) they were seated at the base of quartz crystals quite apart from the bodies of galena. In the Silver Peak mine (Yerranderie) tiny cubes were present with native silver, and though in an area embraced by bodies of galena they were not a part of these deposits, but were lying upon a portion of the lode which had previously been leached, and were therefore of secondary deposition as all the others referred to appeared to be.

The crystals of the Consols, Gem, and Conrad mines were cubes with the angles removed (cubo-octahedra). Those from the Junction North were cubes without modification and similar in form to the small crystals from the Silver Peak mine.

Pseudomorphism after galena was not uncommon, the replacing minerals being cerussite, anglesite, chalcocite, covellite, argentite and tetrahedrite, all of which were found in Broken Hill. Pseudomorphs of cerussite and anglesite were also seen in other localities.

Cuproplumbite.—An impregnation and partial replacement of galena by copper sulphide, was found in the East Consols and British mines (Broken Hill). In some cases after the galena had been partly replaced by copper

Digitized by Google

sulphide oxidation had set in and a further change to cerussite was in progress, the original structure of the galena being retained. The latter varieties were earthy and gray; ordinarily the colours were black to indigo-blue. A good example showing the gradual replacement of galena by chalcopyrite was observed in a prospecting claim at Tenterfield. The replacing mineral was of bright indigo-blue colour.

Johnstonite.—A supersulphuretted lead ore due to the alteration of galena with which it was associated. It formed porous masses consisting of partly altered galena from which a portion of the lead had been leached, leaving the sulphur more or less free. The leaching appeared to have been confined to the interior of the galena deposit. It was found enclosed in limonite in the shallow levels of the Consols mine (Broken Hill).

Joseite [$Bi_3 Te_2 (S Se)_2$].

In dark gray foliated masses with other bismuth ores joseite was found enclosed in quartz, or in the cleavage planes of native bismuth in the Whipstick mines. It was generally associated with molybdenite, which it somewhat resembles, but is darker in colour, harder, and more brittle. A sample from this occurrence was analysed by J. C. H. Mingaye, and found to contain the following:—

Bi	82·92
Te	9·16
Se	Trace.
S	6·19
Mn	·77
Fe	·47
Au	Nil.
Ag	Nil.
Insol.	·32
	99·83

Specific gravity—7·793 and 7·688.

A similar mineral was met with in the molybdenite of Kingsgate. This was proved to contain some quantity of bismuth telluride, but no analyses were made. More recently other discoveries in the Bismuth mine (Torrington), in which it was found with quartz in native bismuth, and in the A.W. mine (Deepwater) with native bismuth and molybdenite, show it is not of rare occurrence. In the latter the only crystal was seen, which was a hexagonal plate resembling some of the isolated tabular crystals of molybdenite. These minerals have not been fully investigated, but they seem to be very similar to, if not identical with, the Whipstick variety.

Kupfernickel (NiAs).

Kupfernickel occurred in small amorphous bunches with willyamite in the Consols mine (Broken Hill). Of pale copper-red colour, it was enclosed in calcite in the siderite zone.

Lollingite ($FeAs_2$).

A deposit of this mineral may be seen 10 miles west of Tingha, where it impregnates granite in specks to solid lumps of several pounds weight. The occurrence is bunchy, and the quantity available is probably not large. It resembles mispickel, but is of lighter tin-white colour, and amorphous. It was partly analysed by H. P. White, with the following result:—

As	50·90
Fe	26·93
S	·50
Insol.	22·00

Digitized by Google

A quantity of much purer material than is indicated by this analysis was subsequently obtained by further prospecting in the same deposit.

Marcasite (FeS_2).

Clusters of well formed crystals and crystalline masses of marcasite associated with pyrite and chalcopyrite were of common occurrence in the Lobb's Hole mine (Yarrangobilly). Pretty groups were also found in sinking a well, at a depth of 80 feet, in the Armidale district, but on exposure they became disintegrated. It is an unstable mineral in a climate not dry enough to retard its oxidation.

Mispickel (FeAsS).

Many deposits of this mineral have recently been opened, comprising irregular but important bodies of ore which should be found to contain finer crystallisations than have yet been seen in this State. The largest individual crystals met with up to the present were in Webb's Consols mine (Emmaville), where they formed columnar groups, but they were rather fragile owing to intercrystallisation. There are also in this mine aggregations of small crystals of tabular habit enclosed in a matrix which decomposes on exposure and leaves them free. They may be seen strewn over the surface at the mine.

Groups of similar crystals occupy crevices in the rock of the Valla mine (Urunga), where they are associated with octahedral crystals of pyrite. Small, but perfect, silver-white crystals with unusually bright metallic lustre, were found in vughs in the Tulloch mine (Armidale) with quartz crystals. The material enclosing these was also mispickel of massive type containing high silver values. Equally perfect little clusters of crystals were enclosed in clear colourless quartz at Kingsgate. The endomorphs of this field were generally in crystallised quartz; in this case it was a transparent amorphous variety which permitted the examination of the inclusions from all angles while still surrounded by the matrix.

An amorphous cobaltic variety was met with in British and Consols mines (Broken Hill), enclosed in blende and siderite respectively.

Of the more massive types the most interesting was the radiating variety of Lucknow which contained high gold values. In earlier years some of the occurrences must have been very fine. Large bodies of clean ore showing no crystallisation are mined in the Ottery mine (Tent Hill) where it is associated with pyrrhotite and a little cassiterite. At Pye's Creek (Tenterfield) and Rockvale (Armidale) there are several important deposits, some of them containing quantities of the arsenate (scorodite). In each of the last two localities development is in its early stages, there are also other localities where promising outcrops occur which contain important bodies of this mineral. It is, however, quite common in various mineral veins and isolated deposits of little extent, in which it may be recognised by its silver-white to lead-gray colours with occasional tints of light yellow, and by the characteristic odor when mining operations in it are in progress.

Molybdenite (MoS_2).

Very perfect groups of crystals of molybdenite were found at Kingsgate, though the largest and most plentiful aggregations were seen in the Allies mine (Deepwater). The former were more attractive because they were free from any encrustation which might detract from their beauty, which was

Digitized by Google

not the case with those of the Allies. Large tabular crystals projecting from nests of quartz crystals at Kingsgate were the finest of the crystallisations. The vughs in which they occurred were in themselves very interesting and handsome, as they were lined with quartz crystals that were all perfectly terminated and often transparent. The largest and finest molybdenite crystals of this type were found in Block 45, but similar though smaller crystals completely embedded in amorphous quartz were seen in another pipe in the vicinity. These were so enclosed that the presence of the molybdenite might not be suspected until the stone was broken. The interstitial quartz surrounding these crystals could be removed without difficulty by picking it out piece-meal. With these occurrences there are rarely any accompanying minerals, though bismuthinite was sometimes deposited over the crystals in small bunches of acicular forms in similar vughs.

Of the smaller type of crystals the most perfect groups were obtained in the pipe known as the Water Cut (Kingsgate). Some of these forming aggregates of curved foliated crystals were very perfect in their arrangement and condition. They were built up of imperfect hexagonal plates in which were interleaved thin layers of quartz; the plates could be separated into innumerable laminæ. Similar crystals were found at Dundee in ferruginous quartz, but the plates, which were curved as well as flat, exhibited a radiating structure not seen in the molybdenite of other localities.

Bunches of small crystal aggregates of somewhat similar type were not uncommon in several localities, fine groups were found in amorphous quartz at Warrall Creek (Macksville). Single crystals were seen in the form of hexagonal plates in Block 40 (Kingsgate) and in three of the Deepwater mines. They were small, ranging from a ¼ inch to an inch in diameter though probably larger ones existed. They were found in the broken ore and never seen *in situ* by the Writer.

Kingsgate takes high rank as a molybdenite field by reason of its beautifully perfect crystallisations. If individual occurrences of specially high quality be taken as the standard of excellence, it must be allotted the leading position among such fields. If, however, quantity be allowed to outweigh beauty, the crystallisations of the Allies mine, which in profusion were unrivalled, would place Deepwater first. Vughs containing crystals were met with here and there at Kingsgate, but in the Allies the whole mine was full of crystallisations, there was practically nothing but crystals of both quartz and molybdenite, and the workings were so extensive that as a molybdenite mine it was from this fact alone probably unique.

The crystals of the Allies mine consisted of small to large plates each separated to some extent from the next, the whole forming large bunches in which the hexagonal form could be traced; with them were numerous quartz crystals. The whole of the crystals were coated with silica which detracted from the beauty they must otherwise have had, and it was in this respect that they failed when compared with those at Kingsgate. Beneath this coating, however, the mineral possessed a lustre more brilliant than that of any of the other occurrences of molybdenite referred to, and there could be no doubt of the purity of such perfect crystallisations. The plates of which these groups were formed were generally flat, but a number were bent, a condition peculiar to this mine. The distortions appear to have been effected before the siliceous covering was deposited as there was an absence

Digitized by Google

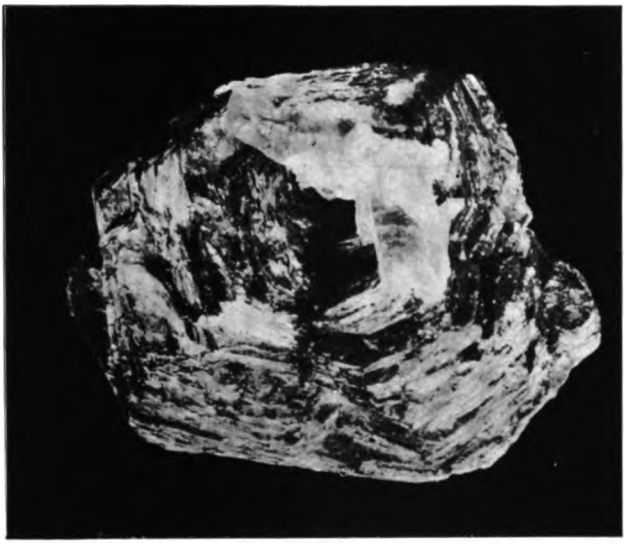


Fig. 1.— Molybdenite (and Quartz) crystals, Water Cut Shaft, Kingsgate.

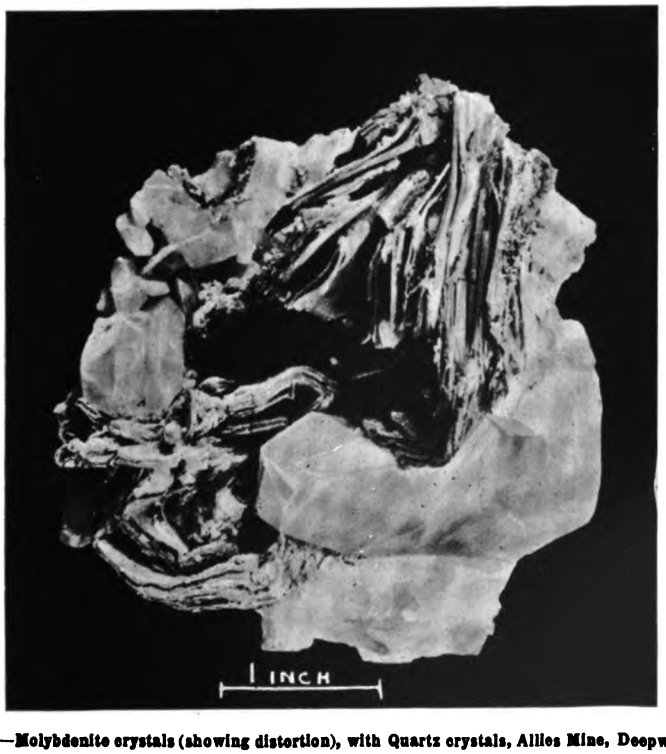
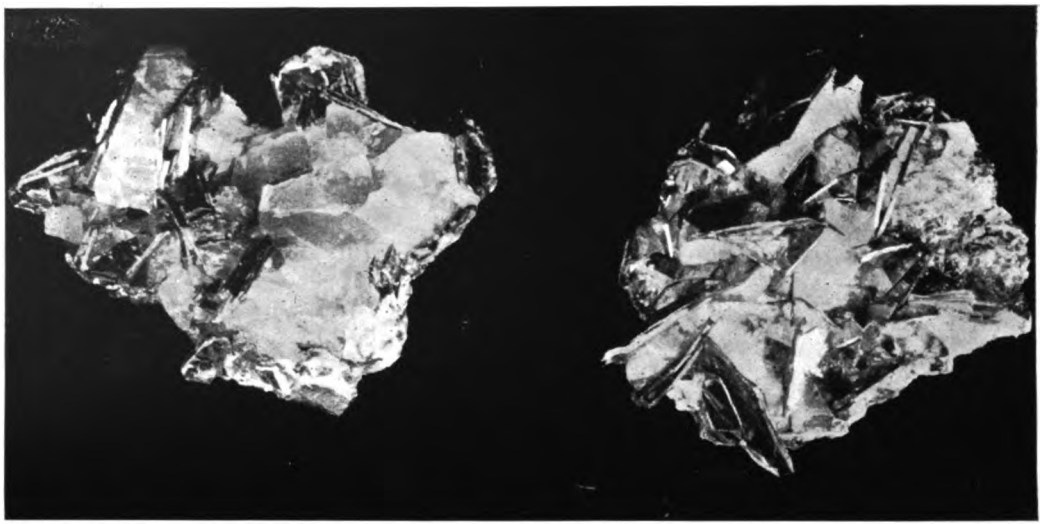


Fig. 2.—Molybdenite crystals (showing distortion), with Quartz crystals, Allies Mine, Deepwater.

Digitized by Google



1 INCH.

Fig. 1.—Molybdenite crystals in Quartz, Road Shaft, Kingsgate.

Digitized by Google

of cracks in the silica, or other signs of interference with its growth. The curvings were both gradual and abrupt and were apparently due to at least three causes. In one instance the quartz crystals, which were very intimately associated with the molybdenite, had probably continued to grow after the latter was in position; perhaps there was simultaneous growth, and this had led to a crowding of material. The force exerted by the quartz in its growth would appear to have overcome the resistence of the molybdenite, which was thus pushed out of position and bent. The second cause was more apparent, many of the crystals were formed in spaces which proved too small to admit of their full growth. They started to grow in a direct line and continued so until they met an obstacle, generally other molybdenite crystals, lying across their path. This interfered with their progress but the growth continued, and therefore some deviation had to be made in direction, which resulted in bending of the crystals. (What appeared to be an analogous occurrence in regard to antimonite crystals is referred to elsewhere.) The third cause was due to a blow which turned up the edges of the soft molybdenite and was more a crushing effect than bending of the crystal. The blow could be received in two ways, either by falling itself or being struck by a falling object. This cause of damage is not uncommonly seen in mines in which there are open spaces. In many of the large quartz vughs a few of the crystals have been found lying detached on the bottom which through some unknown cause had become detached, not necessarily through decomposition of the rock to which they were originally attached like the quartz crystals of The Gulf or the beryls of Torrington, but by a force which was sufficient to break them across. The cause was probably earth movements. A number of groups of crystals—quartz and molybdenite—had been broken off in the Allies mine and these had caused some of the damage sustained by the molybdenite crystals while they were still in position. Some of the fallen masses had suffered by their own fall through the distance was rarely a foot or more. The encrusting silica upon these was apparently deposited after the damage was done otherwise it would have shown some effects of the blow as it peeled off very readily and was never more than a thin sheet. It covered the whole of the molybdenite, but very little was deposited on the quartz crystals and then only on their undersides. It was tested by J. C. H. Mingaye and found to consist of 94·86 per cent. silica with some alumina, iron oxide, &c.

Molybdenite of normal type is plentiful in foliated masses without crystallisation, but there are minor differences in its form. Those with flat leaves easily separable may, though they very seldom do, occur in large sheets (the Writer has them 9½ inches by 6½ inches and 8½ inches by 8 inches, but larger have been found). The most common form is composed of flat or curved foliations which from specks upwards occurred in such abundance in Cooper's and other mines. A distinct sub-variety was found at Kingsgate in which the laminæ were brittle (not flexible) and could not be split into leaves; with its short grain it could be pulverised without difficulty. It was seen in several pipes but never in quantity sufficient to be important.

Pyrite (FeS_2).

This, the most plentiful of metallic sulphides, is often found in very fine crystals, single and compound. Large lustrous cubes formed part of the lode of the United Miners' mine (Major's Creek) and were enclosed in dolomite. Being less bunched than usual many good isolated crystals might have been secured. They occupied certain areas in the lode that was ordinarily

Digitized by Google

composed of massive pyrite assaying several ounces of gold, but where these crystals occurred the values became unpayable. As would be expected, they contained very little gold (under 5 dwts. per ton).

Equally fine crystallisations with the same bright lustre were met with in the Mt. Stewart mine (Leadville) in which they formed large groups of very perfect cubes sometimes over an inch in diameter. They could be seen lining vughs in a large body of massive pyrite of which they formed a part.

Much smaller but perfect crystals were enclosed in the mispickel-bearing rock of the Valla mine (Urunga). The common form was the octahedron, the largest being over half an inch across; the cubo-octahedron and rhombic-dodecahedron were also seen, the latter sometimes composed of clusters of small crystals of the same form symmetrically arranged to make a single crystal. Similar crystals of the same forms occurred with cassiterite in chlorite at The Gulf (Emmaville). All the above possessed the customary even faces of this mineral, but small octahedra were found near Portland which were much pitted through corrosion though enclosed in solid siliceous rock.

Of the amorphous kinds there are many large masses, sometimes cupriferous, which do not require special mention.

Pyrrhotite (Fe_7S_8).

Pyrrhotite was met with in large quantity in the Great Cobar mine with chalcopyrite and magnetite, and in other mines of the Cobar district. It forms large bunches in the stanniferous mispickel lode of the Ottery mine (Tent Hill) in certain sections. Large masses are associated with molybdenite in some of the Kingsgate pipes, and it occurs in large quantity with galena in the Pinnacles mines (Barrier Ranges). In small quantity it was seen in the Consols mine (Broken Hill), but it is a common mineral which may be found in many localities.

In each occurrence it was amorphous and of yellow-bronze colour, generally with characteristic tarnish.

Smaltite [(CoFeNi) As_2].

Smaltite, which resembles cobaltite in appearance, occurred under the same conditions and in the same localities, but in smaller quantity, in the Consols mine (Broken Hill). It was only seen in the vicinity of the large silver deposits but was not found to contain much silver, the highest assay being 42 oz. It was not crystallised like cobaltite but was of similar colour, though rather darker, varying from tin-white to light steel gray. Analyses of this mineral were made by J. C. H. Mingaye, who found it to contain the following:—

	No. 1.	No. 2.
As	69·94	68·76
Co	7·12	7·20
Fe	17·44	17·62
Ni	1·90	1·95
Cu	·31	.....
Sb	·03	.....
Mn	trace	.....
Al_2O_3	·50	·43
CaO	·53	.....
MgO	·22	.....
S	2·14	2·16
CO_2	·22	.....
Gangue (quartz)	·73	.....
Moisture	·06	.....
	100·14	

Silver, 21 oz. 14 dwt. 10 grains; gold, nil.

Digitized by Google

Large bunches of this mineral were met with in the Bismuth mine (Torrington) enclosed in pegmatite, a characteristic formation of this field in which many mineral deposits were found. It was associated with large lumps of native bismuth and fluorite, sometimes with ferberite and rarely crystals of beryl and topaz. Masses of black mica forming part of the pegmatite were often present.

This variety was also tin-white in colour, some portions tarnishing to light metallic yellow and on exposure changing to erythrite. An early sample was analysed by W. A. Greig with the following results:—

As	31·69	45·42
Co	6·15	7·89
Fe	11·55	.....
Ni	2·31	4·84
Al_2O_3	8·86	.....
CaO	1·35	.....
MgO	·67	.....
Bi	·90	.....
Pb	trace	.....
S	·38	·42
Gangue	31·40	.....
O and undetermined	5·04	.....
	100·00	

The partial analysis was of a more recent discovery when the mineral had become plentiful and was found free from gangue.

These various analyses show that the minerals described differ greatly in composition and they might perhaps be separated as sub-varieties. Smaltite, however, is of such indefinite composition that it is considered better to use the general title to cover each variety.

Stannite [$2(Cu_2FeZn)\,S + SnS_2$].

Stannite was found in bunches generally associated with blende, mispickel, pyrite and some chalcopyrite, in varying proportions with the galena deposits of the Conrad mine (Howell). The bunches in themselves were unimportant but in the aggregate they formed appreciable quantities. Large lumps free from other minerals were of light to dark gray colour, but it was often yellowish through admixture with chalcopyrite and always amorphous.

Sternbergite ($AgFe_2S_3$).

This, one of the rarest of silver minerals, was found in the Consols mine (Broken Hill) in a section of the mine which contained several rare minerals. It was attached to a 50-lb. piece of dyscrasite with some pyrargyrite, the whole being enclosed in a gangue of siderite and calcite at a vertical depth of 150 feet. There was but one occurrence of it. When first obtained it was of bronze-brown colour which soon tarnished to violet blue. It was amorphous, almost sectile, and in parts so soft as to mark paper.

A sample which contained traces of pyrargyrite was found to contain 33·94 per cent. silver and 30·76 per cent. iron. The theoretical values are 34·18 per cent. and 35·44 per cent. respectively.

Stromeyerite [$(AgCu_2)S$].

Stromeyerite occurred only in the Consols mine (Broken Hill) where it was associated with other silver minerals. It was found in solid masses of clean material, though occasionally it was seen in an altered condition

Digitized by Google

impregnated with cerargyrite, malachite, azurite or white oxide of antimony, the latter undoubtedly a residue left by dyscrasite which th re was reason to believe had been replaced by various secondary minerals. This mineral formed the most productive ore of the mine and in the large deposits it was generally consistent in value assaying in bulk 9,000–10,000 oz. of silver. It was seen only in the oxidised zone, small deposits reached the water level but did not extend beyond it. It was a tough mineral of dull bluish to greenish black to black colour without metallic lustre. Picked samples assayed rather over 50 per cent. but no analyses were made. The theoretical value is 53·1 per cent. silver.

Tetradymite (Bi_2Te_2S).

This mineral was found at Norongo, near Captain's Flat, in crystalline masses of steel gray colour and metallic lustre enclosed in a yellowish to reddish-brown oxide to which it was being changed (montanite). It has been described and analysed by J. C. H. Mingaye* who found it to contain the following:—

Bi	59·66
Te	33·16
Se	nil
S	4·54
Fe	·42
SiO_2	·40
	98·18

Specific gravity, 7·381.

It was also seen at Nanima, near Yass, in small flakes associated with montanite and other oxidised bismuth minerals.

Willyamite (CoS_2, $CoSb_2$, NiS_2, $NiSb_2$).

This, a new mineral species, has been found only in the Consols mine (Broken Hill) in which it was associated with dyscrasite and kupfernickel, and enclosed in calcite in the siderite zone. It formed small bunches with perfect cubical cleavage, but was not seen in any definite crystal forms. It has been described by E. F. Pittman†, A.R.S.M., and analysed by J. C. H. Mingaye with the following results:—

	No. 1.	No. 2
Sb	56·85	56·71
Co	13·92	13·84
Ni	13·38	13·44
Fe	trace	trace
Cu	trace	trace
Pb	trace	trace
S	15·64	15·32
	99·79	99·91

Specific gravity, 6·87; hardness, 5·5.

(c) TERNARY COMPOUNDS.

Sulpharsenites, Sulphantimonites, Sulphobismuthites.

Bournonite (Cu, Pb, Sb, S_3).

Bournonite is a rare mineral found in limonite with tetrahedrite and other silver and lead ores in the Consols mine (Broken Hill). It was only seen in very shallow levels and generally contained high silver values through impregnation and some admixture with those ores.

* Aust. Assoc. Adv. Sc., 1888, p. 116. † Jour. Roy. Soc. N.S.W., 1893, p. 366.

Digitized by Google

Samples were analysed and the following results were obtained :—

	No. 1.	No. 2.
Pb	29·0	30·0
Cu	8·9	8·5
Sb	25·0	28·5
Fe	3·0	2·06
Ag	5·7	·60
S	22·5	22·89
H_2O	2·9 (by diff)	2·00
Insol	3·0	5·45 (by diff.)
	100·0	100·00

It was also found in the Purnamoota district more or less impure, always argentiferous, amorphous, and in small greenish black or black bunches without metallic lustre.

Cosalite ($2PbS+BiS_3$)

Cosalite is a steel gray mineral occurring in compact and fibrous forms at Duckmaloi, Kingsgate, and Deepwater. The Duckmaloi occurrence was analysed by J. C. H. Mingaye who found it to contain the following :—

Cu	2·50
Pb	33·20
Bi	41·17
Sb	·55
PbO	3·64
SO_3	1·30
S	16·10
Ag	1·11 (363 oz.)
Au	trace
Insol.	·31
	99·88

Specific gravity, 6·940.

In tests made of the Kingsgate and Deepwater occurrences variations in composition were shown, due probably to mixture with other minerals. In these localities the substance was found in odd masses in the molybdenite pipes though not always with that mineral. At Duckmaloi only one boulder was seen which came from an unknown source.

Galenobismutite ($PbBi_2S_4$).—A similar mineral from Kingsgate has been analysed, and, eliminating the small amount of impurities, G. W. Card,* calculates its composition to be as follows, which is near the theoretical composition of this mineral :—

Bi	58·0
Pb	27·0
S	15·0
	100·00

An analogous mineral possessing a radiating fibrous structure was also found at Kingsgate forming small bunches with molybdenite, similar to

* Rec. Geol. Survey N.S.W., 1903, Vol. VII, Pt. 3, pp. 217-219.

Digitized by Google

the occurrence of the more common bismuth minerals, which, as will be seen by the following analysis, contained a much higher proportion of bismuth :—

Bi	74·27
Pb	11·50
S	12·95
Fe and undetermined	·85
Gangue	·43
	100·00

Silver, 10 oz. 0 dwts. 8 grains; gold, 5 oz. 8 dwts. 21 grains.

Jamesonite ($Pb_2 S_2 Sb_5$).

Jamesonite was seen in the Consols (Pinnacles Group) and Lady Carrington (Apollyon Valley) mines, and at Rivertree, in bunches of fibrous structure and lead gray colour, with galena and other sulphides. It is a more uncommon mineral than might be expected seeing that antimony is present in appreciable quantity in so many of the lead sulphide deposits.

Polybasite [$(Ag\ Cu)_9\ (Sb\ As)\ S_6$.]

Polybasite is a very rare mineral which was found in small black amorphous patches enclosed in calcite in the Silver King mine (Yerranderie). It was analysed by H. P. White and found to contain the following :—

Ag	57·96
Sb	5·36
Cu	12·52
S	17·45
As	4·60
Fe	·91
Gangue	·67
O, &c.	·53
	100·00

Proustite (Ag_3AsS_3).

Proustite is recorded as having been found at Rivertree, Yerranderie, and Rockvale (Armidale). The only occurrence known to the Writer was in the Consols mine (Broken Hill), in which it was seen in small light-red hexagonal prisms associated with pyrargyrite in the siderite zone. There was but one occurrence of it and the quantity was extremely limited.

Pyrargyrite (Ag_3SbS_3).

Important deposits of pyrargyrite were met with in the Consols (Broken Hill) and Tulloch (Armidale) mines. In each the mineral occurred in some quantity and there were many pointsof resemblance in its occurrence, though the mines were very dissimilar in other respects. Each yielded clusters of crystals deposited upon crystals of calcite, and impregnations along the cleavage planes. Fine dendritic forms of this kind were seen in the Consols mine.

The lode gangue below the oxidised zone in the Consols is siderite with calcite, in the Tulloch it is mispickel with calcite. In the respective lode

Digitized by Google

fillings the impregnation by the pyrargyrite was very similar, films of the mineral being found in the cleavages of the siderite and in cracks and joints in the mispickel.

The Tulloch mine contained the most crystallised material, but while the Consols occurrences contained good crystals also, the largest bunches were in the form of solid blocks of ore. Each mine produced beautiful little clusters of dark red crystals, the Consols variety being lighter in colour and translucent at the edges. Some of the crystals were black but all gave the characteristic red streak and appeared to be prisms, single and compound, of hexagonal habit. The ore in the Consols assayed 56·3 per cent. silver, the sample tested probably being representative of the massive type, as the result is rather low compared with the theoretical value of 59·8 per cent.

The Consols deposits were generally associated with tetrahedrite and pyrite, rarely with sternbergite and argentite. In the Tulloch the pyrargyrite occurred with tetrahedrite with which pyrite and blende were often associated, the whole being contained within the mispickel.

Pyrargyrite was also met with as films upon felsite at Wolumla and in joints in the lode at Yerranderie and Rivertree. No crystals were seen in these localities except at Yerranderie and these were very rare.

Stephanite ($5Ag_2S+Sb_2S_3$).

The occurrence of stephanite has been recorded at Drake (White Rock and Silver King mines), Rivertree, Umberumberka, and in several of the Purnamoota (Barrier Ranges) mines, but apparently in no case in a recognisable form. That ores containing silver-antimony sulphides were found in these localities is well known and that some of them were rich in silver is equally true, but many were of low silver value and all were so mixed with other minerals that it is doubtful if their separate identity could have been established. Professor Liversidge* in recording the occurrences of argentite states that "in nearly all cases the silver sulphide occurs mixed, more or less intimately, with galena, so that properly it should probably be termed argentiferous galena." If the same method of classification be adopted in regard to stephanite then it may perhaps be said to exist in the above mentioned localities.

The Writer knows of only one mine, the Consols (Broken Hill), in which the definite pure mineral was found. There were several small deposits in which well formed hexagonal prisms and bunches of small crystalline plates were seen. Some of the latter were curved like those of molybdenite and in the more definite shapes the hexagonal form could be seen. The plates were sometimes in clusters of isolated crystals or perhaps arranged in stalactitic form, some of the stalactites of smaller and more symmetrical kinds being less than a quarter inch across and two and a half inches long, the whole consisting of small projecting platy crystals of great perfection. All the crystals were very fragile; the ore is noted for its brittleness; and lead gray to black, the lighter coloured variety being lustrous on one side. The silver value of different varieties was found to be :—65·95, 67·10, 67·40, 67·66, 67·75, 68·20, and 68·40 per cent. The theoretical value is 68·5 per cent.

* Minerals of N.S.W., 1888, p. 39.

Digitized by Google

The stephanite occurred in a gangue of siderite and calcite at a point where there was some decomposition of the lode, which had had the effect of separating the prisms from their base. There were no other minerals with these deposits.

Tetrahedrite.

Freibergite ($4Cu_2S + Sb_2S_3$ with part of the Cu often replaced by Ag—or with other replacements.)

Though not a silver ore proper, tetrahedrite is, apart from the lead ores, one of the most widely distributed of argentiferous minerals. As a constituent of non-argentiferous lodes it is frequently the only mineral present which contains silver in appreciable quantity. An example of this is shown in the analysis of this mineral from the United Miners', essentially a gold mine (Major's Creek), whose lode consists of pyrite.

The silver content varies greatly. Taking the United Miners' ore as representative of the poorer grades, the other extreme would be represented by the Consols (Broken Hill) occurrence in which the average value was about 20 per cent. (170 as compared with 6,533 oz.). There are, however, innumerable variations between these extremes, but such great differences in composition affect the general appearance of the mineral very little, and except that there are lighter or darker shades of colour they all appear very much the same, therefore it is at sight impossible to estimate its silver contents with any degree of accuracy. In the Consols mine the lighter gray variety contained the most silver, but in other localities, as at Rivertree where the lightest colours were found, the ore was comparatively poor, whilst somewhat richer ores at Yerranderie and Webb's mine (Emmaville) were much darker.

With the exception of an imperfect tetrahedron seen in the Consols mine the whole of the ore was massive. It occurred in isolated bunches which, with the exception of the large deposits of that mine, were never extensive enough in themselves to be of much commercial importance, though when there was a general dissemination through the lode, as was sometimes the case, the silver value was materially increased. In the lower levels of the Consols mine it was found distributed in small specks with thin films of pyrargyrite in siderite over certain areas, unlike the large rich concentrations of higher levels in association with other silver minerals.

The general average of the silver value of this mineral from the different mines ranged from 500 to about 1,200 oz. per ton, the richest, omitting the Consols deposits, probably being found in the War Dance Extended (Purnamoota), the only mine outside of Broken Hill, except the Umberumberka, in which it was met with on the Barrier Field. The assay value of that occurrence was 2,500 oz.

In the Consols mine the tetrahedrite in the oxidised zone was enclosed in limonite, and in calcite and siderite in the lower levels. At Yerranderie and Umberumberka it was associated with galena in siderite; in the War Dance Extended mine in siderite without other minerals; in the Tulloch in mispickel; in the United Miner's in pyrite; In Webb's (Emmaville) with pyrite, blende and mispickel; at Rivertree with quartz, pyrite, blende and mispickel.

Digitized by Google

The following analyses of this mineral were made by J. C. H. Mingaye :—

	United Miners' Mine.	Webb's Mine. Yerranderie.	
Cu	36·10	28·44	27·57
Sb	16·37	22·51	20·08
Zn	6·65	8·78	4·94
Fe	2·34	7·14	3·92
Bi	·29	absent	.....
Pb	trace	·75	11·49
As	5·29	2·47	1·85
CaO	3·98	·72	.....
MgO	·30	·15	.....
CO_2	2·30	·61	·42
SO_3	trace	trace	.....
S	23·52	24·14	21·43
H_2O	·06	.....	·22
Au	·01	absent	trace
Ag	·52	2·46 (2·468)	2·65
SiO_2 and undetermined	2·27	1·83	5·43
	100·00	100·00	100·00
	per ton. oz. dwt. grs.	per ton. oz. dwt. grs.	per ton. oz. dwt. grs.
Fine gold	3 5 8	nil.	trace
Fine silver	169 17 8	806 4 4	867 12 12

The highest silver value recorded by Dana* is 31·29 per cent. Some of the assay results obtained from the Consols deposits of clean tetrahedrite were :— 6,050, 6,664, 6,994, and 7,036 oz. or about 18½ to 21½ per cent. In one or two small deposits assays were as low as 3,352 and 3,453 oz., but the general average was about 20 per cent. (6,533 oz.).

Schwatzite.—A mercurial variety of tetrahedrite, was met with in small bunches and specks closely associated with, or enclosed entirely in, cinnabar in the Pulganbar and Broadwater mercury mines (Clarence River). It was always amorphous, dark grey in colour and limited in quantity. The Pulganbar ore was found to contain 3·74 per cent. mercury, 9 per cent. copper, and 54 dwts. silver. A recent determination by W. A. Greig gave 4·3 per cent mercury.

(*d*) CHLORIDES, BROMIDES, IODIDES AND FLUORIDES.

Atacamite ($CuCl_2 + 3H_2CuO_2$).

Atacamite occurred with malachite in vughs and rock joints in the Umberumberka East mine (Barrier Ranges). The malachite was composed of short capillary crystals resembling velvet and was strewn over with isolated dark green crystals of atacamite. Some large slabs of the rock were encrusted with these minerals but they were too fragile to remove intact. The crystals of each mineral were very perfect in form and condition and some interesting combinations were seen. The openings were extensive and entirely lined with the crystals. As they appeared before they were disturbed they presented a beautiful spectacle.

Boleite [$3(PbClH_2O, CuClH_2O) + AgCl$].

A few very perfect cubical crystals of boléite were met with in the South mine, but like several of the unusual minerals of Broken Hill the quantity

* A System of Mineralogy, 1888, p. 103.

Digitized by Google

of material was extremely limited. The forms were cubes and cubo-octahedra, those which the Writer received at the time of their discovery being cubes showing no point of attachment with the matrix. The colour was bright indigo-blue. They were analysed by A. D. Carmichael and J. O. Armstrong* of Broken Hill and found to contain the following:—

Ag	8·25
Pb	47·20
Cu	19·20
Cl	13·50
O calculated	6·10
H_2O calculated	5·44
	99·69

Hardness, 3·5; specific gravity, 5·02.

More recent investigations elsewhere seem to show that silver is not an essential constituent of this mineral, and the chemical formula is given as $PbCuCl_2(OH)_2$.

Cerargyrite (AgCl).

The purest examples and the largest quantities of cerargyrite occurred in the Consols mine (Broken Hill). Some large, round, flat, symmetrical, cheese-shaped masses were possibly a foot or more in diameter and 3 or 4 inches thick, of clear translucent green colour. Solid colourless and green encrustations of fibrous structure over an inch thick were attached to masses of chloro-antimoniate of silver. These rich secondary minerals were derived from the alteration of dyscrasite and are referred to elsewhere in these notes (see Dyscrasite). The green variety assayed 70·24 per cent., and the colourless 72·80 and 73·10 per cent. silver. No other silver haloid upon the field approached these results. The theoretical value is 75·3 per cent.

A common form of occurrence was in yellow-green films through the lode material with an occasional rich concentration of the mineral in almost solid masses enclosed in the limonite forming the lode. These occurrences resembled those in the Purnamoota mines in which, as the lodes weathered down and became disintegrated, they were set free, and then became "shode" stones, locally known as "slugs." In the dry climate of the Barrier Ranges they were able to resist disintegrating influence upon the surface over long periods, as was shown by their rounded forms

Silver chloride was the common mineral in the outside silver mines of the Barrier field, but its exact composition was known in very few cases. Both cerargyrite and embolite were recorded, but it was impossible to separate them without chemical tests. It is assumed that most of the occurrences were of the former variety and therefore they will all be embraced by this heading.

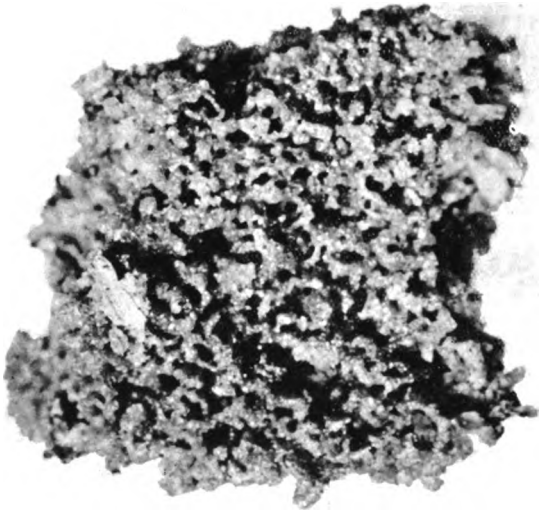
Solid plates a quarter to half an inch thick were found in rock joints in the Black Bird mine (Silverton). There was no gangue and the chloride was not continuous, though little was done to prove how far it extended.

Films of chloride of silver impregnated schist at Purnamoota and formed a coating in the joint planes between garnets and the enclosing schist in the Silver Crest mine (Silverton). It was found as solid veins through a lode of azurite in the War Dance mine (Purnamoota). In similar veins it was associated with red hematite in the Model Republic mine in the same

* Liversidge. Jour. Roy. Soc. N.S.W., 1894, pp. 94-98.

Digitized by Google

Digitized by Google



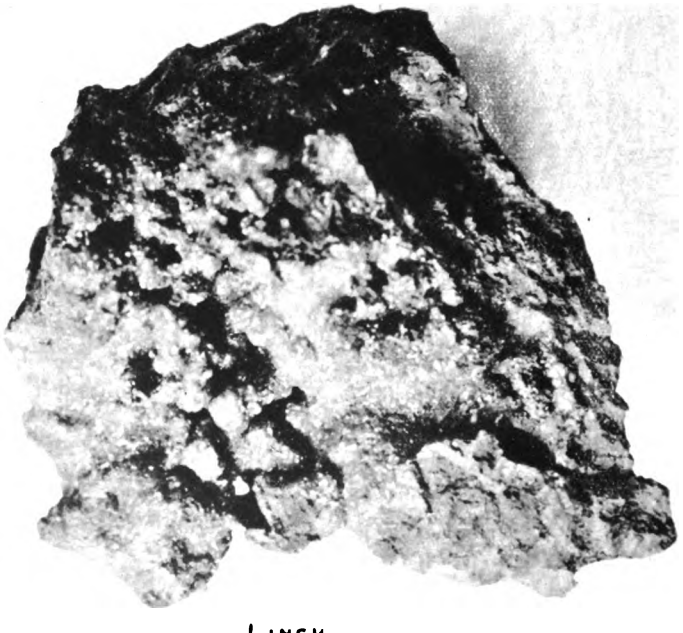


Fig. 1 (Upper).—Embolite, Proprietary Mine, Broken Hill.
Fig. 2 (Lower).—Cerargyrite, Aust. B. H. Consols Mine.

Digitized by Google

district. In the Lily mine (Thackaringa) it was met with as loose nodules with earthy malachite and also forming layers in limestone. In the Atlas mine (Purnamoota) it occupied cavities in barite, the assay value of a parcel being 180 oz., though much richer specimens of it were seen. In the New Year mine (Apollyon Valley) it occurred in vughs in limonite and not impregnating the gangue as was invariably the case. The chloride in bright yellow crystalline clusters was evidently a later deposition than the other ore-bodies of this mine. It was found in quantity occupying little channels through which solutions passed and from which it had probably been precipitated. This was the only occurrence of the clean pure silver-chloride mineral seen in the mass outside of Broken Hill. The best of the others were pure in patches.

Cerargyrite, which was proved to contain no bromine or iodine was met with in schist near Euchareena. It was much tarnished and resembled some of the Barrier coralloidal occurrences of this type.

Though embolite was so common, cerargyrite was unproved in the Broken Hill lode; apparently it did not exist there.

The colour of the pure mineral is yellowish-green, the translucent, colourless, and deeper green varieties were only seen in the Consols and they bore little resemblance to other occurrences. In most cases the chloride was tarnished to gray, brown, or black, the colour, particularly of the "slugs," being affected to some extent by the limonite which had contained it. They were brown if the limonite was pure, or almost black if much manganese oxide was present.

Crystals were seen in the Consols mine only, covering masses of silver chloro-antimoniate. They were of octahedral habit and not uncommon.

Embolite [Ag (Cl Br)].

Among the silver haloid minerals outside of Broken Hill it seemed impossible to distinguish the chloride from the chloro-bromide by any difference in appearance. They were generally tarnished, never crystallised and rarely quite free from the gangue. Where these minerals occurred in the pure state and unaltered condition as in the Broken Hill and Consols lodes, they were distinct from each other. The chloride of the Consols was in more massive form, sometimes translucent, often very decided green or colourless, and was not found in coralloidal bunches. It also possessed a coarse fibrous fracture which was peculiar to this mine. The chloro-bromide was not translucent, was less varied in colour, being neither colourless nor of such deep shades of green, and its most common form was coralloidal. In general it is unsafe to attempt a division of these minerals by a comparison of their physical characters as owing to the varying ratio of the halogens to each other each mineral seems to merge into the other. The two types as found in these lodes were, however, well investigated many years ago by chemical tests and apparently they could be regarded as distinct combinations. The silver value of a specimen of clean embolite was found to be 65·53 per cent.

In the Broken Hill lode embolite was a common mineral, especially in the higher levels. Large blocks of cellular manganic-ironstone from the outcrop were thickly encrusted with it. Stalactites of psilomelane and crystals of cerussite were also coated with crystalline deposits. Waxy looking masses found in vughs in the manganese oxide had delicate crystals of cerussite implanted upon them. Coralloidal masses of great purity were quite common

Digitized by Google

and beautiful in their combination with other minerals or by themselves. It impregnated the great body of massive cerussite and in kaolin formed plates or films often partly changed to native silver, a similar occurrence being seen in limonite. Veins consisting of coralloidal groups were enclosed in kaolin and garn t sandstone, but i s various forms and combinations were very numerous.

In the shallow levels bunches were observed which had been formed upon earlier deposits of the same mineral. The deposition of the first had evidently been completed before the second was laid down, as each type was distinct in color, form, and general appearance, indicating probably some difference in composition also.

Splendid deposits were found in all the mines of the Broken Hill lode, the best probably in the Proprietary. It occurred in many shades of yellow and green and was frequently seen in crystal forms. Cubes over a quarter-inch across were found in the Proprietary mine, but the larger crystals were somewhat defective; octahedral forms were more rare. Pseudomorphs of native silver after the coralloidal form of embolite were also found in this mine.

Fluorite (CaF_2).

Deposits of fluorite of a rich transparent light to dark green colour occur in several parts of The Gulf (Emmaville) accompanying wolfram ores. A body of it associated with quartz crystals was met with in the pipe known as Rumsby's, in which there were large amorphous blocks and sometimes imperfect cubes. Similar deposits and crystals were seen in other parts of this field, but as their discovery was only incidental to wolfram mining no effort was made to prove their extent., It is probable, however, that appreciable quantities could be found (100 tons were obtained for industrial uses in Sydney), but it does not outcrop and would need to be searched for.

These occurrences, in which colourless varieties were also seen, possessed a ready cleavage, and being transparent little flakes of native bismuth have been detected as inclusions.

Very interesting occurrences were found in Hart's mine (Torrington) in which light green crystals were formed upon crystallised quartz or tinstone, or on both. Some had a border of dark purple along the edges and were made up of a number of small crystals (cubes) each with the purple line partly around their periphery, though in mass they formed one symmetrical crystal. There were also small cubes which were wholly purple. Possibly other varieties will be found as their occurrence in this mine is of very recent date.

Bunches of a light green opaque variety were met with in the Bismuth mine in which mining for bismuth was being carried on. They enclosed, and were enclosed by, masses of smaltite. Small purple cubes were also found in Edward's molybdenite mine (Deepwater). A variegated variety occurs in isolated blocks enclosed in greisen (?) near Tingha. Small purple fragments are associated with chromite at Barraba.

In the Broken Hill lode it forms patches in the sulphide zone with spessartite and other minerals, of pink, gray, brown, and purple colours. At Mount Robe it may be seen forming a vein of the purple variety.

Iodembolite [Ag(Cl,Br, I)].

Iodembolite was not uncommon in the Broken Hill lode over thirty years ago. It occurred in crystalline aggregates resembling embolite, but was

Digitized by Google

harder, of more decided yellow and less sectile. It did not extend far into the oxidised zone, but formed one of the group of shallower minerals which had a limited vertical range. With other silver haloid minerals it has been examined and analysed by Messrs. Prior and Spencer* who show that the relative amounts of the isormorphous constituents Cl Br and I vary considerably. They state that the combinations AgCl, AgBr, Ag (Cl Br) and Ag (Cl Br I) represent sub-species of one main species for which the general formula Ag (Cl Br I) is proposed.

Iodyrite (AgI).

Iodyrite was found in considerable quantity in the Broken Hill and Consols mines, and is the more interesting as being the only silver mineral besides native silver known to be common to both lodes. Very fine groups of crystals on limonite were met with in the Proprietary mine of a type that was rare; among the finest examples were crystals deposited in vughs in limonite in which cracks had been followed through which probably the mineralising agent had passed. They were the largest seen and were in groups without blemish. Large groups of hexagonal prisms also from this mine were coated with a greenish-brown substance which detracted from the perfection they would otherwise have shown. Some of the prisms were large but none of their type were seen without this coating. The most common forms were films to thick layers in kaolin, and small specks, plentifully disseminated through the early siliceous and ferruginous ores. In slickensided portions of the kaolin it had been changed to metallic silver, a similar occurrence being met with in limonite. It was found generally throughout the lode, but the best examples were from the Proprietary mine.

The largest individual deposits were met with in the Consols mine (Broken Hill) in which it formed a thick canary-yellow mantle covering some of the large silver deposits. This had little or no cohesion and on being disturbed broke into crystalline fragments in which hexagonal prisms and triangular plates, all very small, could be seen. It was plentiful; many bags of very pure material were often filled with it from a single deposit.

Small hexagonal prisms with native silver were found in the East Consols mine (Broken Hill) but it was not seen in any mine on the Barrier Field outside of Broken Hill. It was met with in the Iodide mine (Condobolin) in small quantity in 1912, the first discovery of this mineral in that portion of the State.

In colour it was generally canary-yellow, but in kaolin it varied from light yellow to yellow green.

Marshite (CuI).

Marshite is known to occur only in the Broken Hill lode, but has been met with in several mines in small pink-gray to red tetrahedral crystals deposited in vughs upon limonite, psilomelane, cerussite, cuprite, or earthy malachite. It was seen in single crystals or in groups of various colours in close association, but was always very limited in quantity.

Miersite (4AgI, CuI).

Miersite is a very rare mineral of the Broken Hill lode and probably from the Proprietary mine. It was found upon limonite in small canary-yellow crystals whose crystallographic characters are similar to those of marshite. It has been described by L. J. Spencer, M.A.†

* Min. Mag., 1902, Vol. XIII, No. 60, pp. 177-185. † Min. Mag., 1901, Vol. XIII, Nos. 59, pp. 41-45, and 60, p. 183.

Digitized by Google

Nantokite (Cu Cl).

Nantokite, also one of the very rare minerals of the Broken Hill lode, was found in the South mine in a boulder of limonite and cerussite. Associated with it were some cuprite and native copper with a little oxy-chloride to which it was being changed. It was colourless, amorphous to crystalline without any definite crystal form, and possessed good cleavage and lustre when freshly broken. It remained for years exposed to the atmosphere at Broken Hill with little alteration, the only change being the loss of lustre and the faintest of coatings of a pale green, which appeared to protect if from further oxidation. At the seaside it soon changed to an efflorescent oxy-chloride. Upon analysis it was found to contain :—

Cu	64·28
Cl	35·92
	100·20

Tocornalite (AgI, HgI,).

Tocornalite was found in the Proprietary mine (Broken Hill) as a deep yellow powder which quickly blackened on exposure to sunlight. The change was superficial, when scratched the yellow mineral was again revealed. This variety of mercury-silver salt was of rare occurrence, but there were analagous compounds found in kaolin generally associated with the cinnabar-iodyrite, or red varieties, which have been described under cinnabar. Their mineralogical identity has not yet been determined and they form a very doubtful group. All were associated with iodyrite.

Professor A. J. Moses* records having examined "a small specimen of impure limonite from the Broken Hill mines which was coated on one side with a thin layer of bright scarlet or red colour. Under the microscope this proved to be made up of little sharp-edged cubes. The examination suggests very definitely iodide in isometric crystals of hexoctahedral (holohedral) class.

"Mr. George Smith mentions† iodyrite, associated with a bright red mineral, readily tarnishing on exposure, and found to be sulphide of mercury.

"The specimen examined has been in my possession over a year, and and has not noticeably tarnished, but as the mineral coccinite is said to change on exposure, it may be that the sulphide of mercury will will prove to be mercuric iodide here described.

"It does not seem that the name coccinite can be at once applicable to the acute rhombic pyramids of Castillos‡ and the cubes from Broken Hill mines, and it is hoped that more material may be found for further examination."

The mineral investigated by Professor Moses was associated with limonite, and had apparently been obtained through the Writer. It would in that case be definitely identified as a Consols mineral, no gangue of mercury compounds of similar character was known by the Writer to occur elsewhere at Broken Hill. There is not the slightest doubt that sulphide of mercury was present, and in large proportion, in the Consols mineral, nor that it perceptibly blackened in sunlight in a few seconds. No microscopic examination was made, however, so the crystals recognised by Professor Moses, assuming they were from the Consols mine, were his particular discovery.

* Am. Jour. Sci, 1901. Vol. XII, pp. 98-99. † Journ. Roy. Soc., N.S.W., 1893, p. 372.
‡ Dana. A System of Mineralogy, 1888, p. 117.

Digitized by Google

Digitized by Google

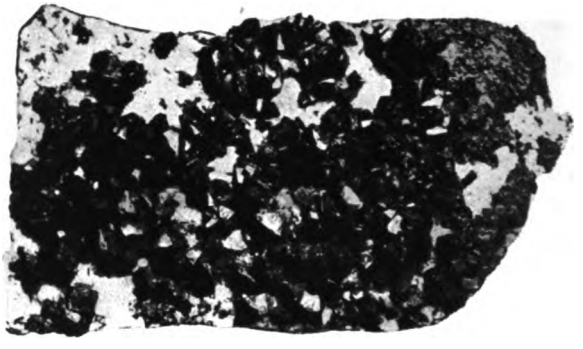


Fig. 1.—Cassiterite crystals, on Granite, Tingha.

Fig. 2. - Cassiterite crystals, on Greisen, Glen Eden.

Digitized by Google

The limonite was very siliceous and resembled light brown jasper. There was but one occurrence, and the Writer would suggest that if any of the material examined by Professor Moses is extant, a fresh fracture would disclose the impregnation of red mercury sulphide, whose presence owing to tarnish might otherwise be unsuspected.

This mineral is distinct from tocornalite, and is referred to here as one of the mercury compounds of Broken Hill, of which little is known, and which have never been definitely classified.

(*e*) OXIDES.

Anatase (TiO_2).

A few small crystals of anatase were found embedded in clay in a mass of wolfram (ferberite) bearing greisen in the Wild Kate mine (Torrington). They were tetragonal, doubly terminated of pyrmidal habit, and of slate-brown colour. They were determined and crystallographically examined by Dr. C. Anderson, M.A.*

Bismite (Bi_2O_3).

In its mixed form with the carbonate, bismite is probably the most widely distributed of the bismuth ores, though it occurs in rather limited quantity in many of the deposits, and is of far less economic importance than native bismuth. It is most frequently seen as impregnations in granite, in pulverulent patches which are not amenable to the ordinary methods of concentration. The largest deposit, near Torrington, yielded by concentration but a small percentage of its bismuth contents, only the more compact portions were recovered. It was found in granite in many parts of the State, particularly in New England and Whipstick, sometimes mixed with molybdite.

At Nanima (Yass) it was more compact though of earthy form, and with the carbonate (bismutite) and tellurate (montanite) was worked on a commercial scale. At Elsmore and Skeleton Creek (Glen Innes) and elsewhere it has been met with as rounded grains and fragments with tinstone concentrates, but the quantity was never sufficient to be of much commercial value.

The most solid variety was found in molybdenite pipes, in which it had resulted from the oxidation of native bismuth. It could be seen as an incrustation or completely altered throughout. All stages of its alteration from native bismuth were shown in the molybdenite mines of Deepwater.

It was always earthy, either pulverulent or compact, of straw to canary yellow when forming an incrustation upon metallic bismuth, reddish yellow to yellow brown in the altered solid lumps, and nearly white as the proportion of intermixed carbonate increased.

Cassiterite (SnO_2).

The most perfect crystals of cassiterite were found at Elsmore and Glen Eden (Glen Innes), each forming clusters upon a base of greisen, in single crystals and in groups, the latter sometimes so closely packed that the underlying rock was scarcely visible. In colour they were generally black, but there were many red, yellow, and light brown crystals with splendent lustre, all forming objects of great beauty. The Glen Eden examples displayed less variation in colour, being generally bright black with shades of

* Rec. Aust. Mus., 1922, Vol. XIII, No. 5, p. 207.

Digitized by Google

brown, translucent and perfect. Those from Elsmore were equally perfect, some were even transparent in amber and rich red crystals, the latter showing opalescence and probably capable of being used for gem purposes. Zonal growth was seen in various colours—black, red, orange and nearly white, in definite lines and perhaps all present in the same specimen. There were doubly terminated crystals, some showing no evidence of attachment to the matrix. The richer colours were only seen in the loose crystals, which, however, were not always abraded. The large groups from each of these localities were wonderfully perfect and lustrous; they were probably unequalled in any other locality in this State.

The Gulf (Emmaville) occurrences were very fine, but they lacked the more brilliant lustre of those just described. Some of the best were found coating quartz crystals in groups, it may be as large as the crystals they were investing; they were especially interesting owing to the crystallisation of both minerals. There were also many fine groups formed of aggregations of small black crystals of distinct type, much intergrown and quite unlike any found elsewhere. Large slabs of quartz or granite covered with crystals were not uncommon on this field, where they lined fissures in the containing rock. The crystals were, however, rather crowded together and were thus less perfect than the more separated occurrences of Elsmore and Glen Eden. At Dundee crystals of the single isolated type were seen embedded in crystals of muscovite, accompanied by quartz crystals. These were very perfect and highly lustrous; owing to the triple crystallisation they were unusually interesting, but they were very rare.

At Tingha also there were many crystallisations which seemed inferior only because of the perfection of those of other fields. Slabs of granite were covered with crystals in the impregnated joints of the rock somewhat similar to what was seen at The Gulf, but they were less fine; as a compensation they were sometimes accompanied by small crystals of rutilated quartz distributed among the crystals of tinstone. Small crystals of a type peculiar to Tingha were enclosed in soft granite. These formed crosses, or, where the branches were numerous, bundles of projecting crystals, the whole mass assuming a spherical shape.

Small crystals were plentifully distributed upon quartz crystals at The Oaks (Tingha) forming pretty clusters, but they were much inferior to the larger crystallisations of The Gulf. In an adjacent mine upon the same line of lode similar crystals of quartz were found also associated with tinstone. In the first instance the tinstone came last and was deposited in crystals on the quartz, in the second it had apparently preceded the quartz and was amorphous.

A number of fine crystals were seen at Waukaroo (Barrier Ranges) about thirty-five years ago. They were distributed through the rock in single crystals, twins, and groups; though perfect in form they lacked the bright lustre of those of New England.

Of the amorphous varieties some large masses were recently found in Hart's mine (Torrington). They contained little druses of minute crystals and resembled some of the impregnations of The Gulf, Tingha, and other localities. They were nearly always black though many had a brown tint, but they did not contain any bright and varied colours.

Alluvial tin which is partly derived from the disintegration of ores of this type contains in many localities considerable quantities of ruby and resin tin which

Digitized by Google

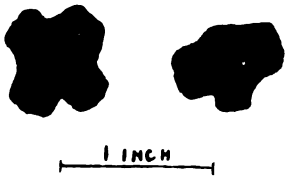


Fig. 1.—Crystals of Cassiterite, Tingha.

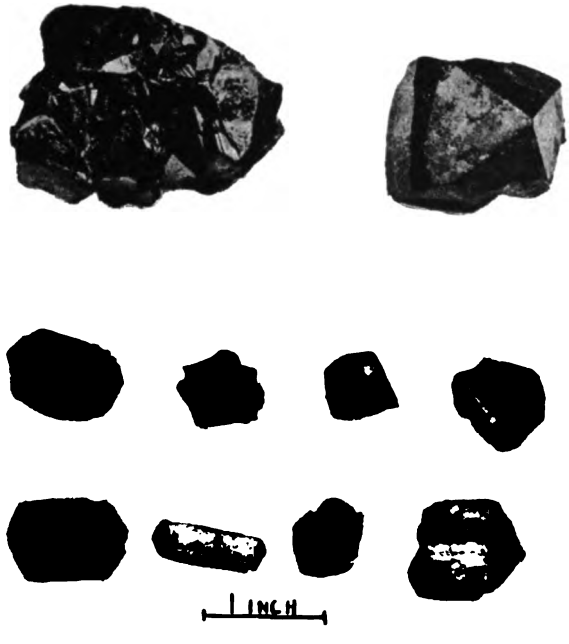


Fig. 2.—Crystals of Cassiterite (the last three "Ruby Tin"), Elsmore.

Digitized by Google

Digitized by Google

obviously could not have come from them. Quite recently a mass of granular friable tinstone was found in the alluvium at Tingha which was composed of crystalline grains, some transparent, resembling an aggregation of small red garnets. It is perhaps to deposits of this kind that the coloured alluvial grains might be attributed if it existed in sufficient quantity, but it does not appear to be known *in situ*. Ruby tin in the form of pebbles and slugs was occasionally found, but the disintegration of these would not explain the origin of the red and amber transparent grains which in certain localities are found in the alluvium in such quantity.

The commonest kind of alluvial tinstone is in the form of small more or less rounded grains, generally black, but often showing a great range of colours and differing in various localities. Less frequently larger fragments are found of black to gray and rarely white. "Slugs" weighing many pounds each were found at Tingha and The Gulf, especially on the latter field, rounded through attrition and resembling potatoes. They were, however, rather uncommon, and only met with in the vicinity of the lodes from which they had been shed. Smaller and more angular pieces were more plentifully and widely distributed.

An unusual association with an earthy form of azurite at Gumble (Manildra) investigated forty years ago was found to contain high tin values in ores containing much copper. The only record now available shows the value to have been 22 and 32 per cent. respectively, but there were still higher assays of that period which the Writer is unable to recall.

The following sub-varieties of tinstone have been seen in different districts:—

"*Leaf Tin.*"—Consists of thin black leaf-like layers interleaved with similar flakes of quartz, forming a compact whole. From Tingha.

"*Needle Tin.*"—In small, lustrous, black, perfect prisms forming little groups with quartz crystals on aplite. From Tingha.

"*Slime Tin.*"—An impregnation in quartz as brown coloured layers, but with no division between them, thus resembling agate. Being very hard, it has been found to take a good polish. From the Ottery mine (Tent Hill).

"*Wood Tin.*"—Occurs in the alluvium as small grains at Howell and Tingha. Rounded fragments weighing 3 or more ounces from the Gilgai showed well-marked concentric structure. The quantity obtained in each of these occurrences was very small.

Conradite.—A mineral recorded by P. J. Thibault,* F.C.S., as having been found closely associated with the stannite deposits of the Conrad mine (Howell). Mr. Thibault states that—

> "Conradite can hardly be termed an ore as it has not been mined in masses, nor has it ever been recorded in the free state. . . . It cannot be isolated from the stannite by mechanical but only by chemical means as it forms one of its constituents. The composition is given as $7\,SnO_2 + Fe_2O_3$, being a compound of stannic and ferric oxides containing :—
>
> | | |
> |---|---|
> | Sn | 68·44 |
> | Fe | 9·20 |
> | O | 23·34 |
> | | 100·98 |
>
> To the naked eye conradite has somewhat the appearance of red oxide of mercury. Examined under a strong glass it resembles fine garnets."

* The Metallurgy of Tin, 1908, pp. 27, 28.

Digitized by Google

With the exception of the western district with its great variety of crystallised secondary minerals there is no part of the State which produces such beautiful specimens as those of New England. Many are of the highest quality and it is difficult to decide which are the finest. Beryl and topaz have claims to this distinction because of their purity and perfection of form, but they fail because the best are not found in their original groups. Molybdenite and cassiterite have stronger claims and each possesses some advantage over the other. Both are perfect, but molybdenite is doubly attractive by reason of its crystallised associate (quartz). Cassiterite has less attractive associates, but in compensation it possesses a range of beautiful gem-like colours, so the merits of each would appear to be equal.

Cervantite (SbO_4).

Cervantite was often seen in the upper parts of antimonite lodes, but not in all, like galena, antimonite may outcrop without appreciable alteration. The best examples were met with in the Hillgrove district where a number of veins were worked, and in which the sulphide could be seen in all degrees of oxidation. Pseudomorphs after antimonite were not uncommon showing complete change to the oxide, or perhaps with blades of the sulphide remaining unchanged in the centre. A very delicate capillary form of antimonite from the Baker's Creek mine was changed to cervantite at one end, the other end being unaltered.

It was found at Gresford in an antimonite vein near the surface, and at Ardlethan sufficiently hard and compact to take a good polish. Interesting specimens from that field showed by concentric markings of different shades of colour the gradual change from the sulphide, the progressive stages being nicely illustrated with some sulphide still remaining as an unaltered core.

Chalcotrichite (Cu_2O).

This beautiful mineral was met with in the South mine (Broken Hill) in aggregates of capillary crystals upon cuprite, but was of rare occurrence.

It was also found in the Cadia mine (Cadia) in similar but smaller crystals, lining little vughs in cuprite. In each locality the forms were most delicate, of bright cochineal-red colour.

Chromite ($Fe\ Cr_2O_4$).

Chromite is found in many localities in irregular masses in serpentine, showing little variation in its ordinary granular structure and iron-black colour. Deposits of all sizes occur in the Barraba-Bingara district, in one of which the interesting green secondary mineral described under Ouvarovite (garnet) was met with. With this particular deposit was a variety of the chromite enclosed in serpentine which was in the form of spheres like rather small peas. These were examined by G. W. Card and found to consist of aggregations of minute octahedral crystals. Small patches of fluorite were also present.

It has been found also in the alluvial drift of New England in very perfect little bright octahedral crystals.

Corundum (Al_2O_3).

Corundum occurs in the surface drifts and deep leads with sapphire in fragments and rarely in crystals. In the Inverell-Tingha district in flakes and

Digitized by Google

other amorphous forms. At Sapphire (Inverell) it is amorphous and often crystallised, some of the crystals being an inch in diameter. The colours are light to dark brown, gray, blue-black to black and parti-coloured.

Sapphire.—This variety of corundum is met with in some quantity in tin-sluicing operations in various localities. Stones of fair quality are obtained in Cope's Creek (Tingha) commencing a mile or more east of the township and continuing for a distance of about 3 miles north-west. They are most numerous in certain areas which are near the junction of small tributaries with the creek from the eastern side, in which direction are various basalt flows. Under this basalt there are deep leads that have been, and are still being worked for tin ore, but which do not appear to contain sapphires. They become less frequent as the distance from the basalt increases, but there are many other occurrences of this rock much nearer the sluicing areas with which there are no associated sapphires or other gem stones. This basalt is, however, of an earlier period and far advanced in decomposition, so that if such minerals had been associated with it they may long since have been changed beyond recognition.

The sapphires of this field therefore seem to be contained in the surface drifts, but they are found in the deep leads underlying basalt at Topper's Mountain, Gilgai, Elsmore, and Copeton, all of which are within a radius of 3 to 18 miles of Tingha, at depths varying from 50 to 60 feet (Copeton) and 100 to 200 feet. Those found at Topper's Mountain at a depth of 180 feet were very similar to the Tingha stones, but the others were more or less bleached, the Gilgai and Copeton occurrences very much so, they were also smaller, fewer, and of inferior quality.

Some of the Tingha stones are clear and free from flaws, but nearly all are dark in colour and lacking in lustre. Blue is the prevailing colour, but colourless and yellow varieties are found, with many intermediate shades of colour. Those not waterworn are cleavages or fractures, and of these many of the better quality are too flat or thin for gem purposes. Stones of good colour have from time to time been cut, but it was not realised locally how lacking they were in the finer qualities of the gem until a comparison had been made with those from the field known as Sapphire. A few parti-coloured stones are found, including the peculiar variety which shows a central colourless triangular patch surrounded by the blue, a type seen also at Sapphire. They are more waterworn than those from that field, and do not show the same interesting crystallisations.

Six-rayed stones are not uncommon on both fields ranging to half an inch in diameter at Tingha, but being opaque, or at best slightly translucent, they are useless for ornamental purposes. Similar cleavages, which are from pyramidal crystals, without the star have been met with nearly an inch in diameter. Zonal banding is seen in short prisms on each field, but it is rare.

Sapphires have been found in many other localities of which the following may be specially mentioned: Rocky River (Uralla) of a peculiar milky blue colour and quite opaque. At Glen Elgin, Glen Innes, Inverell, and Bald Nob. The colours are generally light to dark blue and nearly colourless. All are waterworn and rarely show any crystallisation; they are unsuitable for gem purposes.

At Sapphire, 17–18 miles east of Inverell, mining for this gem only is being carried on at several points over a length of a mile. The surface loam in

Digitized by Google

which the stones are found is a typical black soil resulting from the decomposition of basalt. The loam is treated by means of pulsating jigs, a method of treatment which separates the clay from the coarser material and permits the gems to be plainly seen. As a means of concentration this method leaves much to be desired owing to the comparatively low specific gravity of the sapphire, and a further process of sizing and hand-shaking in circular sieves is necessary to further concentrate the graded material; it is then easy to pick out the gems by their colour. A similar method is adopted at Copeton in treating the diamond wash, but the colours of the sapphire are more distinctive than the extra lustre of the diamond, so there is less risk of missing it.

A number of sapphires have been found embedded in or attached to fragments of basalt, an association which was not observed in other localities, perhaps because the stones of the Sapphire field, which are much more angular and ragged, have not been subjected to the same amount of attrition. So far no gem stone (zircon has also been seen attached to fragments of basalt at Sapphire) has been seen in the solid basalt, though a number of shafts have been sunk through this rock in other districts (to reach the stanniferous and auriferous deep leads) even in those localities in which sapphires abound.

The gems of Sapphire possess the essential qualities of colour and lustre in a higher degree than those from the other localities referred to. Crystals are common but the larger ones are generally opaque or slightly translucent. The smaller crystals are of better quality, but the best stones seem to be those of irregular shape which are capable of yielding the larger gems. The most common type of crystal is the single pyramid, some forms of which are long in comparison with their thickness, tapering to a fine point surprisingly sharp considering the amount of abrasion they have suffered. Double pyramidal crystals are also not uncommon, but those seen were less transparent. Among the rarer forms are little groups showing parallel growth, long thin four-sided prisms from which two of the faces have been eliminated, and short hexagonal prisms showing zonal growth in their banded structure. The colours range from dark to very light blue, and colourless to yellow and yellowish green. Parti-coloured stones are more numerous than at Tingha and display more alternate horizontal bands of colour.

The following minerals were found associated with sapphire:—

Almandine.—Macquarie River (Mumbil).
Balas Ruby.—Sapphire (Inverell).
Cassiterite.—Copeton, Tingha, Howell, Elsmore (deep lead), Bald Nob, and other localities.
Diamond.—Copeton, Tingha, Howell, Macquarie River (Mumbil).
Garnet.—Copeton.
Gold.—Uralla, Tingha, Macquarie River (Mumbil).
Jasper.—Copeton, Tingha.
Limonite-pisolitic.—Tingha, Sapphire.
Magnetite-pisolitic.—Tingha, Sapphire.
Pleonaste.—Copeton.
Rutile.—Tingha.
Titanic Iron.—Tingha, Sapphire.
Topaz.—Tingha, Copeton.
Tourmaline.—Copeton.
Wood Tin.—Howell.
Zircon.—Copeton, Tingha, Sapphire, Howell, Uralla, Macquarie River (Mumbil).

Digitized by Google

Cuprite (Cu_2O).

The finest crystals of cuprite were obtained in the Broken Hill lode, the largest being octahedra about 1 cm. across. Each mine yielded some, but the best were found in the Proprietary and South mines; in its crystal form it was, however, rather an uncommon mineral. Some of the crystals formed splendid groups ; perfect in shape, lustrous and translucent, possessing the characteristic finish of the secondary minerals of this lode. Most of the groups however, were covered with a slight gray encrustation due to oxidation. They were in cavities in limonite generally, but were also found on massive cuprite, other oxidised copper minerals being present, sometimes with occasional specks of embolite or other silver haloids, perhaps with native silver.

At Cobar good crystals were associated with, or on, native copper, some being partly changed to malachite. In similar form cuprite was seen in rock joints at Drake also with native copper, but on a smaller scale. More perfect groups in the Cadia mine (Cadia) were in openings in boulders of ironstone which also contained the massive variety with native copper. The cavities were lined with octahedra, smaller and less lustrous than many from Broken Hill, but they were more numerous and of clear translucent ruby-red colour though so closely bunched that they appeared much darker.

The massive form in the Broken Hill lode was coated with other oxidised copper minerals which were probably mainly derived from it, and occasionally with silver haloids, but always in small patches sparsely distributed. Larger masses were common at Cobar as dark solid and light red more earthy kinds, generally with the amorphous variety of malachite. Ore of this class was found in quantity at Drake forming the principal mineral of the Poor Man's lode. At Cadia it impregnated ironstone with bunches of native copper. In small quantity it is met with in the oxidised zone of many copper mines.

Gahnite.

Automolite, zinc gahnite ($ZnAl_2O_4$ with sometimes a little Fe), is of frequent occurrence in Broken Hill and district. It is present in the main lode and the mineral veins of that locality, and is distributed over a wide area. It is found in well formed octahedral crystals of dark green colour, and has been described by E. C. Andrews, B.A.* A sample from the Nine Mile mine (near Broken Hill) analysed by J. C. H. Mingaye was found to contain the following :—

SiO_2	1·50
Al_2O_3	54·08
Fe_2O_3	1·40
FeO	8·46
Mno	·28
ZnO	33·29
CaO	·06
MgO	·89
	99·96

Specific gravity, 4·45.

Kermesite ($2\,Sb_2S_3 + Sb_2O_3$).

Kermesite was found in the Consols mine (Broken Hill) in the upper siderite zone, in small clusters of cherry-red capillary crystals associated with native and sulphide of antimony.

* The Geology of the Broken Hill District, 1922, p. 103.

Digitized by Google

Very similar crystals were seen at Rivertree with various sulphide minerals, but the quantity was very small in each case.

Limonite ($H_6Fe_4O_9$).

Limonite, though a non-crystallised mineral, occurs in many interesting forms. The pure fibrous kind was often met with forming botryoidal or mammillated coatings of vughs in various lodes. The layers of which the mineral was formed, however, were not thick or extensive, and therefore no really good examples were seen. The most interesting were pseudomorphs after siderite, which were rather common in certain mines on the Barrier Field in its early days. The largest and most perfect were found in the Consols mine in shallow levels where there were many vughs whose roof was formed of typical rhombohedral crystals. The original siderite had been very perfectly developed, each large crystal being covered with minute scale-like acute rhombohedra. On the pseudomorphs the fine edges and angles of these tiny crystals were as perfect as when in their original condition. Generally, however, they were covered with deposits of foreign minerals, all the vanadinite of this mine was contained in the vughy portions of the lode of which these pseudomorphs were a part. The vughs served as a receptacle for deposits of manganese minerals which were found in this mine only at these levels. In the vicinity of the rich silver deposits the pseudomorphs were encrusted with a layer of crystallised iodyrite. *In situ* the combination of the bright yellow silver mineral upon the dark brown crystals of limonite formed interesting specimens, but as the iodyrite was loose practically the whole of it fell off when disturbed.

In the mines of the Day Dream-Purnamoota district there were many with vughy lodes in which these pseudomorphs were seen, but they were smaller and less perfect. The most usual form was a more acute rhombohedron locally known as "tomahawk iron," which was so frequently seen in close proximity to the deposits of silver chloride that it came to be regarded as a favourable indication of richness, as quartz crystals are considered a guide in molybdenite mining.

Pseudomorphs after pyrite are more common; they were seen at Caloola Creek (Bathurst), Rockley, and in other localities, the unaltered pyrite still remaining in the centre of some crystals. The forms included rhombic and pentagonal dodecahedra, but the bulk of them were cubes. They may be found strewn over the surface on the Rockley-Oberon road. Those at Caloola Creek sometimes showed coarse gold embedded in them.

The botryoidal form was best illustrated by the beautiful stalactitic clusters of the Sunny Corner mine of forty years ago which were a foot long and perfect in form and condition. Of the stalactitic type there were many varieties: the largest being contained in the Broken Hill lode, but many of these were rather soft and friable, similar to those found at Cobar. In each of these localities masses of a light cellular variety were common. Limonite formed the neucleus of some of the finer of the psilomelane stalactites of the Broken Hill lode.

Groups of stalactites were found in vughs in the Bobbie Burns mine (Peak Hill), showing the beautiful iridescent colours due to tarnish so often seen upon the harder varieties of this mineral.

Digitized by Google

Masses of the mammillated kinds were generally seen in the same mines but they were less common. Some were coated with a glaze, and others, as at Broken Hill, were invested with other minerals, such as calamine or embolite.

In the massive state it is a very common mineral, found very often in large quantity. It formed the lode material of most of the mines of the Barrier Ranges, where it consisted of two very important divisions, one the ordinary silver-bearing gangue, the other barren. These two varieties differed in several respects, but to the uninitiated they appeared much the same, and their resemblance led to some costly mistakes in mining. It is a common constituent of lodes everywhere, and is therefore very widely distributed.

A pisolitic variety in association with the decomposing basalts of Tingha, from which it appears to have been derived, exists in large quantity. Much of it is met with in the alluvium in basalt country, where sluicing is in progress, in round, pea-like forms.

Magnetite (Fe_3O_4).

Magnetite occurs in large quantity in the Great Cobar mine, associated with chalcopyrite and pyrrhotite. It forms a lode passing through the Consols leases (Broken Hill). This was assayed, but contained no silver. It has been found by E. C. Andrews in the Broken Hill lode. Masses of a highly magnetic quality may be seen at Lionsville, and in association with molybdenite at Dundee.

At Gulf Creek (Barraba) a variety was found exhibiting very strong polarity. A pisolitic variety is frequently met with in the alluvial drifts of Tingha and Sapphire. In every case it was of massive type.

Massicot (PbO).

An impure variety of massicot was associated with cerussite in some quantity in the Iodide mine (Condobolin) as a yellow pulverulent mineral at a depth of about 80 feet. It was interesting as being the only occurrence of this mineral yet recorded in this State. It was associated with iodyrite, also the first of its kind to be discovered in that portion of the western district. Its value was found to be Pb 54·05 per cent., Sb 5·43 per cent., Ag 165 oz., Au trace, so that it was of indefinite composition. It had, perhaps, been derived from the alteration of antimonial galena, and may have contained some bindheimite.

Melaconite (CuO).

The black encrusting mineral so frequently found with decomposing chalcopyrite is often regarded as an oxide of copper, but the only occurrences of this mineral known to the Writer in or beyond this State have been associated with other oxidised ores. It is, moreover, rather a rare mineral of limited extent.

It was found as an encrustation on cuprite in the Broken Hill lode. Also impregnating clay in association with cuprite and native copper in the Cadia mine (Cadia).

Opal—[(SiO_2), water usually present, but is regarded as unessential.

Precious Opal:—The quality of the opal of Lightning Ridge is so perfect that a comparison would convey little meaning which simply suggested that

Digitized by Google

no existing field is capable of yielding similar gems. If one may judge from descriptions, the historic stones of the past could not compare with the perfection of pattern, richness of colour, size, and the large and gorgeous flashes of the gems of this field. With the black background, which so intensifies their marvellous beauty, it may well be doubted if such another field ever did exist.

Not much seems to be known generally of the different varieties of opal that are found at Lightning Ridge, and still less of the field and its great potentialities. It may not be realised that the area covered by the sandstone containing the opal is so great that the portion already tested is insignificant, and that there is so much scope for prospecting in promising localities that the ultimate expansion of the known gem-bearing areas seems practically assured.

The opal has been found in isolated localities which are often several miles apart: the Grawin field is 30 miles south-west of Lightning Ridge. Surface resemblances which exist at each point where the opal has been mined may also be seen in many other parts of the district, some many miles distant from any worked portion. There are no known indications which suggest with any certainty whether any particular locality may be opal-bearing, but there are variations in the structure of the surface rock, such as stony ridges, which are always present where it has been found. There are many of these in various parts of the field which are as yet untouched. It is, of course, possible that these areas may be barren, but where geological conditions appear to be identical it is not unreasonable to suppose that equal potentialities may exist.

The Grawin is a productive field, and the opal is similar to that of Lightning Ridge, but the quality seems to be rather inferior. At the time of the Writer's visit the green colours predominated, and there was a greater proportion of vein material, but the opal was found under the same conditions and in the same rock.

In a few outlying areas a single shaft has been sunk, with disappointing results. The indications met with were favourable, but the opal was lacking. This negative evidence was not without its value, but it could hardly be expected that the sinking of a shaft would necessarily determine the possibilities of a district. It is most unusual to strike opal while sinking, though it has been done, and prospecting can only be said to commence after the shaft is completed. Without assistance the miners are naturally reluctant to try their fortune in new ground. Indeed, there are few of them who could afford to carry on prospecting operations long enough to give an unknown district a satisfactory trial. They therefore concentrate their efforts around and in the vicinity of proved areas, even after these appear to have been exhausted, and very often make further important discoveries in them. New and untried localities, therefore, do not possess the same attraction as those whose worth has already been demonstrated.

The opal has been found at all depths from 5 to 90 feet., the most valuable deposits at 40 to 50 feet. It is quite possible it may exist at still greater depths, but, judging from experience gained elsewhere, the water level would probably fix the limit beyond which the opal would be valueless.

The deepest and most productive claims were in operation sixteen years ago, but are now more or less inaccessible. At different depths in these claims there are as many as four distinct horizontal layers of altered rock from

Digitized by Google

2 feet upwards in thickness, and it was in these that the opal was found. Later developments upon other parts of the field showed that these layers are not essential to the existence of the opal, though there was always the same alteration in the rock. These later discoveries were, however, not of equal importance to those of earlier years.

The best quality opal is found in nodular forms roughly resembling an olive in shape and size, probably showing no colour and perhaps no semblance to opal until chipped, and evidently due to replacement of the enclosing rock. One of the features of these stones is the large colour pattern they display; there may be two or more colours, or perhaps only one, which might be a rich brilliant, glowing, fiery red when viewed from one direction, and just as vivid green when the angle is slightly changed. The combination of colours is, however, never ending, and every taste in this respect could be gratified. The blue is the least prized, then the green; the gold-green and red appear to be the most valued. Tastes differ, however, and values vary accordingly as could be seen in dealing in them by the various buyers. Nearly all are combined with the black variety and form a class peculiar to this field. There are milky varieties of a distinct type somewhat resembling those from White Cliffs, but possessing more brilliant colours, larger pattern, and superior in every respect, especially beautiful in artificial light.

Vein opal is found in joints in the rock, but is of less frequent occurrence and of less relative value.

Reptilian remains are sometimes met with, large vertebræ and portions of the jaw with teeth intact, and in one instance the complete skeleton of an animal as large as a cat was seen, the replacing opal being of a red translucent variety with no play of colours. Many shells (bivalves) have been found, also replacements of wood with the structure beautifully reproduced, but the variety of fossil remains is smaller than at White Cliffs. As a rule any fossils are broken up when found to extract any coloured opal they might contain, and many good and probably invaluable specimens have thus been needlessly destroyed.

The opal is sometimes encountered unexpectedly and the grating of the pick upon it may be the first intimation of its presence. There is "kindly" ground, however, which experience has taught may indicate its proximity; but many good stones have been broken before the possibilities of the ground were recognised, or even thrown over the dump with the waste rock, to be recovered perhaps by fossickers many years later.

Values vary greatly from time to time and no arbitrary rule can be made which will admit of a close comparison with the stones from other fields. There must always be a great divergence of opinion as to values owing to different tastes in the choice of the stones. The fields which produce the most valuable gems are Lightning Ridge and White Cliffs, and some idea of the wonderful perfection of those from the former may be gathered from a comparison of the selling values of the stones from each field. The best quality from White Cliffs sells for as much as £50 per oz. That from Lightning Ridge is not sold by weight, but by the piece at so much per carat, which has exceeded £1,000 per oz., or fully twenty times the value of the White Cliffs gem.

Opal of a different kind and of good, though relatively inferior, quality was found at Rocky Bridge Creek (Mandurama) in vesicular cavities in trachyte. Some pretty stones were obtained, but it was difficult to remove

Digitized by Google

them from the rock; with the primitive methods used the waste was very great and none of appreciable size were secured. The cavities were sometimes only partially filled and as prospecting extended below the water level the opal was seen to be in a bleached condition and devoid of colour.

A similar occurrence at Tintenbar (Ballina) has yielded some fine stones, which were originally enclosed in cavities in the basalt, but, owing to its decomposition, they had become detached and were found loose in the soil at shallow depth. The opal occurs in rounded but irregular pieces conforming to the shape of the cavities it had formerly occupied. In general character it showed many differences from the varieties above described; it possessed a black cloudiness which, however, differed widely from the black opal of Lightning Ridge, and its colours were more blended and therefore less distinct. Gems of brilliant and varied colours were obtained which would be more highly regarded but for the occurrences of Lightning Ridge, which are infinitely superior in every respect. Many were cracked, a very serious defect, which considerably diminished their value as gem stones.

The opal possesses no colour of its own and its iridescence has been explained in different ways. It has been stated* that the spectroscope and polarising microscope have shown it to be due to the interference of light caused by the succession of thin laminæ.

Common Opal.—This variety may be seen in loose fragments on the surface in many localities, most frequently in the neighbourhood of basalt, also in or near serpentine. Large loose fragments are met with in the old river beds underlying basalt in the Tingha–Inverell district. In colour it is gray in the serpentine, light to dark brown when loose on the surface, and brown to black in the deep leads.

Wood Opal.—A variety also of common occurrence at Dubbo, Leadville, and many parts of the New England district, sometimes in large blocks several feet long showing the structure of the wood it had replaced. It was seen in the deep leads underlying basalt and in surface alluvium; often compact and capable of taking a good polish. The best varieties of this class were found at Copeton, where it displayed alternate bands of gray and white, representing the original structure of the wood. It is generally in yellowish, brown, or gray masses, but is frequently bleached white on the outside through long exposure.

Hyalite.—Small but fine clusters of small stalactites of hyalite were met with in joints in the serpentine in the Mount Fibro asbestos mine (Barraba), sometimes coated with dendrites of manganese oxide. In botryoidal form it lined cavities in basalt near Warialda. In each locality it was colourless and translucent. It is rather an uncommon mineral.

Psilomelane [$(MnBaK_2)_5O_9+Aq$ (composition doubtful).]

This mineral formed a large portion of the manganic-ironstone outcrop of the Broken Hill lode together with masses of gray amorphous pyromorphite, of which in places it contained a large percentage. It was compact generally, but in parts more or less cellular with deposits of embolite in some of the openings, the earliest of their kind seen in this lode. In the shallower levels vughs were frequently met with containing very fine stalactites and botryoidal clusters of this mineral upon which embolite, cerussite, or

* "The American Mineralogist," 1920, Vol. 5, No. 1, p. 8.

Digitized by Google

calamine crystals were deposited. The stalactites were of all sizes, long and slender, or short and stout, very small or very large, single or in groups, in folds, and in many other forms. Some were compact, others were in layers like an onion with a tendency to peel off.

The implanted crystals formed beautiful specimens, the most attractive perhaps being large rounded colourless crystals of calamine which formed a special type. Other calamine crystals, rather small and more pointed, were also very fine and very plentiful. Embolite in single crystals or in groups upon the stalactites made a very choice combination. Cerussite similarly deposited was less frequent, and though perfect in form it was overshadowed by the finer crystallisations of this mineral in the vughs near by. The latter were among the finest cerussites seen in the lode, the white glistening crystals contrasting well with the black base of the psilomelane. Where the stalactites were free from other minerals they were still most interesting and perfectly formed unique specimens.

Deposits of this mineral may be seen at Cookamidgera, Deepwater, and in many other localities. It is a common mineral which rarely shows any interesting forms and is not found in crystals. Its colours range from dark steel gray to black.

Pyrolusite (MnO_2).

Some good specimens of this mineral were found in the Consols mine (Broken Hill) forming stalactitic clusters of small steel-gray crystals. They were pendent from pseudomorphous crystals of limonite and were accompanied by deposits of wad. It was seen only in the shallow levels.

Quartz (SiO_2).

Very large crystals of quartz of normal type up to several feet in length and occasionally doubly terminated were not uncommon in the molybdenite pipes of Kingsgate over twenty years ago, but of later date the occurrences have been smaller and less interesting in their associations. Pretty groups can, however, still be seen upon which crystals of molybdenite or bismuthinite, or perhaps both, may be found; but the interesting endomorphs of earlier years are now rarely, if ever, met with; as the particular pipes in which most of them existed are idle.

The largest crystals of the present period were contained in a quartz pipe near Deepwater, which, being almost destitute of values, was prospected for a short time only. Groups weighing several hundredweights could have been obtained, all colourless but impaired in quality by a slight coating of secondary silica which is found upon so many of the minerals of this district; over this small crystals of pyrite were distributed.

The finest crystals of New England were probably produced by the Butler mine (Torrington). They were of the drusy type, very perfect, lustrous and enamel-like. Similar but smaller crystals were found in the Dutchman mine in the same district. The drusy character of the latter was imparted by a great number of crystal points of which there were hundreds within an area of less than 2 inches square. Operations carried on in these mines in recent years disclosed none of these crystals. The same law seems to apply to most mineral deposits, the finest crystals are invariably those of shallower levels.

Similar drusy crystals were found in Rumsby's mine at The Gulf, which are referred to under ferberite, but they did not exhibit the polish of the Torrington variety.

Digitized by Google

The extensive association of molybdenite and quartz crystals in the Allies mine is referred to under molybdenite. In this mine the peculiar deposition of molybdenite upon the very apex of the quartz crystals was seen, as it had been some years before at Kingsgate.

Among the more interesting associations with other minerals were groups of cassiterite crystals upon crystallised quartz at The Gulf. The quartz was colourless, white or smoky, and both minerals were in well-formed crystals. They were sometimes intergrown, but this did not indicate that they were of simultaneous deposition. The quartz was the first formed, and after the tinstone had been deposited there appeared to be a later growth of quartz which partly covered the tinstone and was itself somewhat distorted in the process. In some cases, however, it was clear that the tinstone was a much later arrival as a few of the quartz crystals had been broken off their base while *in situ* and had acquired a crystalline covering of silica over the broken end; upon this crystals of the tinstone had been formed. In this particular deposit small crystals of tourmaline were among the crystals of tinstone.

A number of interesting clusters of crystals, some bronze-yellow or bronze-brown, others black, and nearly all doubly terminated, were found in the Rare Metals mine (Dundee). All had been coloured by various solutions of iron and manganese oxides with a very pleasing effect .In the same locality doubly terminated crystals of a gray, opaque, enamel-like variety were seen in the Surprise mine. In each case the crystals were found lying loose in vughs and had not been attached to any part as they were crystallised com pletely all round.

The finest groups in every respect except size were found in the Conrad mine (Howell). They were colourless, perfectly terminated, in good condition, and formed clusters of much beauty. Doubly terminated crystals were equally perfect, but their brightness was often hidden by a coating of white siliceous material. The groups were rendered more interesting through the deposition of crystals of chalcopyrite which were found upon some of them as described in the reference to that mineral. All were found in vughs in the quartz lode of that mine.

Probably no mineral found in the State displays such variety of form, due largely to distortions and renewed growths, and none contains so many endomorphic enclosures. As examples of these varieties the following may be mentioned :—

1. Colourless to white transparent to translucent crystals which, after completion of their pyramidal terminations, had resumed their growth on a smaller scale on the apex of the first crystals. These, after a short additional growth and without forming a termination, again contracted to half the diameter, grew a little longer and finished with a perfect termination. The terminations of the original crystals could be seen as " phantoms."

2. Transparent crystals abruptly widened (without forming a termination) to double the diameter and finished with pyramidal terminations.

3. Normal type doubly terminated crystals resumed growth at one end as four-sided prisms (two faces being obliterated) and terminated with only two pyramidal faces.

4. Flat transparent crystals, some doubly terminated, having four sides and terminating with four pyramidal faces.

Digitized by Google

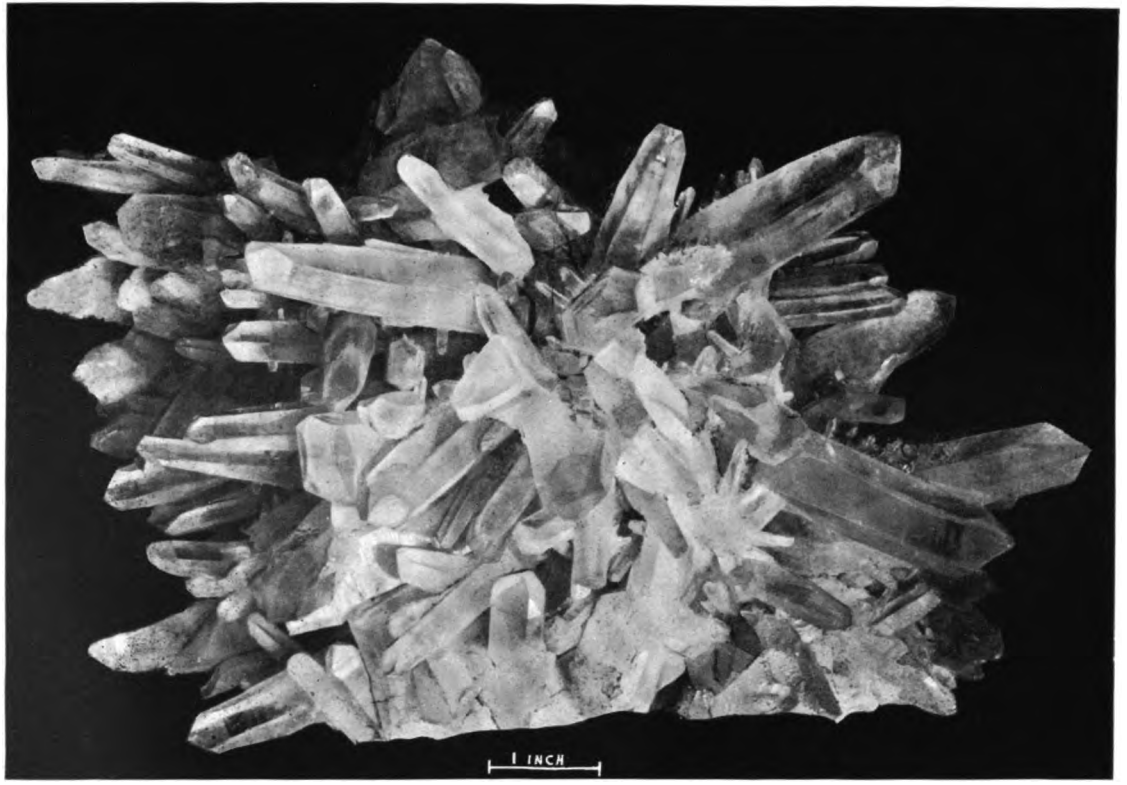


Fig. 1.—Quartz crystals, Conrad Mine, Howell.

Digitized by Google

Digitized by Google

These varieties were from Maurer's molybdenite pipe at Kingsgate. They were found lying loose on the bottom of a vugh, where they had evidently been formed. They thus resembled the occurrences in the Rare Metals mine.

5. Groups of crystals all doubly terminated, some showing penetration of crystals through each other. Seen in the Rare Metals mine.

6. Colourless crystals encrusted with yellow opaque secondary quartz, which had been subsequently entirely removed from the apices, revealing the original termination, the other portions of the crystals being unaffected. Upon the apex of some of the crystals, however (after deposition of the secondary growth) crystallised cassiterite had been deposited, which had protected them from any destructive action, and the whole of these crystals with their secondary encrustation were thus unaffected. Found at Topper's Mountain (Tingha).

7. Colourless crystals enveloped in a thick secondary growth of crystallised quartz. This having reached to near the apex of the original crystal, ceased its growth, and the apices of the crystals with a short length of the prism were left protruding.

8. Hexagonal prisms the half of which had been longitudinally developed about an eighth of an inch longer in relation to the other half. Three faces of the pyramidal termination therefore projected beyond the other three. These crystals and those described under No. 7 were found at Tingha. None of these were individual crystals, they were representative of groups of which each crystal presented the same features.

These crystallographic freaks were found in crevices in the rocks or in vughs. In many of the larger quartz vughs loose crystals are sometimes found which have been broken off *in situ* through causes which are not apparent. Those fractured in this way are often the larger ones, and much force must have been required to break them. The fractures are always covered with a thin film of secondary silica, to heal the wound, as it were. Tiny groups of crystals of secondary growth are often found seated upon the larger crystals and branching off in all directions. The best were seen in the Conrad (Howell) and Dutchman (Torrington) mines. Recently crystals of secondary quartz upon calcite were found in the Central mine (Broken Hill).

Etching was not uncommon, the most interesting example being a transparent perfectly terminated crystal found broken off its base in Hart's tin-mine (Torrington). Upon this crystal there is a series of fourteen approximately parallel lines cut in as with a diamond. They pass over the apex and down the opposite sides of the crystal. Seven of the lines continue beyond the (present) base of the crystal, the remainder terminate before the base is reached, therefore it cannot be a case of parallel growth. A section from the base was microscopically examined, but this threw no light on its cause. In other cases well marked deep groovings have been seen which were irregular in direction, always straight, sometimes radiating, never parallel, and, as a rule, showing on one side only of the crystal. In most, if not all, of these occurrences the cause was due to the existence of small acicular crystals, which had been slightly embedded on the outside of the quartz crystals, but, having become decomposed, had fallen out. The foreign mineral might have been rutile, actinolite, or tourmaline, the last two of which have been seen so embedded. Traces of a mineral believed to be

Digitized by Google

rutile in the last stages of decay have been found in tiny grooves in the quartz crystals. These occurrences, however, could not possibly pass over the apex of a quartz crystal and conform to its shape to form the unbroken lines seen on the crystal from Hart's mine.

An unusual form at Torrington consisted of an aggregation of small transparent, doubly terminated crystals, which crossed each other at right-angles. Though no cementing substance could be seen they formed a rigid mass. The number of crystals pointing in each direction was about equal. They were found in a clay pocket in the wolfram-bearing greisen.

In one instance bunches of crystals of quartz were met with at Fielder's Hill, Torrington, lining vughs which contained wolfram crystals, any spaces on the wall of the vugh not occupied by other minerals being covered with crystals of topaz.

Crystals twinned on the Japanese law were found in prospecting for wolfram at The Gulf. They were transparent and varied from half to one inch in length. Some of the smaller ones were pitted at the base through corrosion in a manner characteristic of so many of the quartz crystals of this field. They had originally invested a large boulder from which they stood out like wings.

In the foregoing notes the crystallised varieties of quartz only have been referred to, but the occurrence of the pure limpid amorphous masses of Kingsgate should be recorded, though they are not now being found. Similar quartz from Copeton when cut and polished proved to possess a brilliancy little inferior to that of topaz.

Endomorphs in Quartz Crystals.

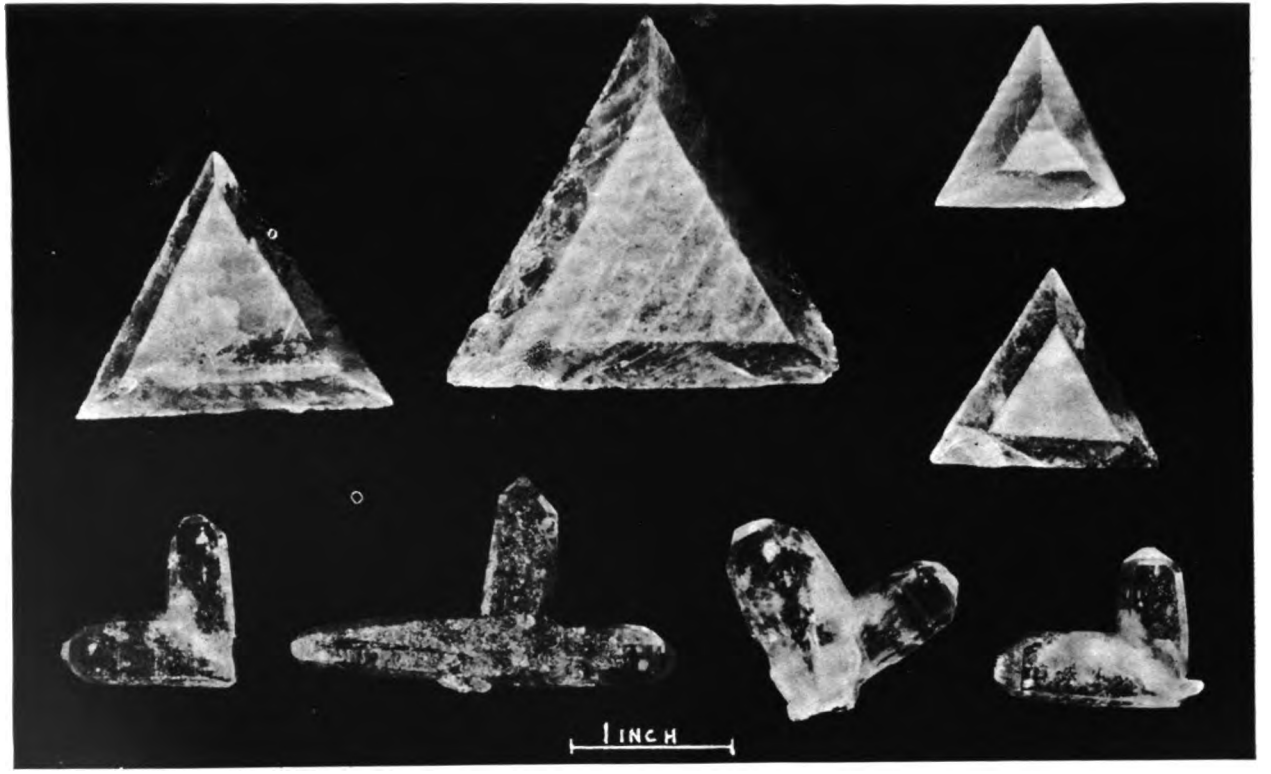
At Kingsgate :—
Molybdenite in flakes.
Native bismuth as wires and small irregular fragments.
Mispickel in crystals.
Bismuthinite in radiating acicular or capillary crystals.

At Torrington :—
Tourmaline in acicular and prismatic crystals.
White prismatic crystals of two unknown minerals found in the Wild Kate and Block 14 mines. The finest specimen was sacrified in an attempt to discover their identity.

At Howell :—
" Phantom " crystal. The outline of the enclosed crystal was not that of quartz as usual, but the same termination was outlined by small greenish-black specks (chlorite ?), which showed on three sides of the original crystal for its whole length. Little tufts of actinolite crystals were also present. The original crystal was free from any inclusion, and after it was formed the small specks of chlorite (?) were deposited on the three sides, also sparsely covering the apex. The actinolite was deposited on the same sides, but not on the apex. The whole was then enclosed by the second crystal, which was unusually transparent.

Galena in crystalline form in the Conrad mine.
Actinolite in brown acicular crystals.

Digitized by Google



Calcite (natural cleavages), Cooper's Molybdenite Mine, Deepwater.
Quartz crystals (Japanese Twin). The Gulf.

Digitized by Google

Digitized by Google

At Bundarra :—

Actinolite in green and brown acicular crystals.

At Tingha :—

"Phantoms," the outlines of the original crystals being plainly visible.

Rutile in acicular and capillary crystals.

Cassiterite in small fragments and crystals.

Tremolite (asbestos ?) in long fibres.

Small greenish-black globular forms (chlorite ?), in addition to small black particles of another unknown mineral.

Two unknown grey crystals three-quarters and an inch long respectively, a quarter-inch broad at the base and tapering to a sharp point. Small bunches of yellow-brown capillary rutile also present in the same specimen.

In several localities quartz may be seen containing a large number of tiny cavities, but whether there are liquid enclosures is not known. They are of common occurrence, and offer an interesting field for microscopic examination.

At Oban :—

Rutile in acicular crystals similar to those found at Tingha.

Agate.—Agate shows as angular fragments or pebbles in the alluvium after tin sluicing in several parts of the Tingha-Inverell and Emmaville districts. Some of the better qualities which were polished showed good characteristic banding, but the quality generally was inferior.

Amethyst.—Amethystine quartz was found in several parts of New England, the best varieties occurring at Tingha. It was also met with in the lode of the South Blocks mine (Broken Hill. In each case the mineral was in pretty groups of crystals of a delicate purple colour, but none were of a shade dark and rich enough for use as a gem.

Cairngorm.—Crystals of cairngorm were not uncommon in clayey vughs in greisen with some of the wolfram deposits of Torrington, and were often very perfect in form. A large bunch of loose crystals was found whilst prospecting for tin on the surface of Hart's mine leases in that district, all of which were penetrated by crystals of tourmaline. They were very perfect, of a dark brown colour, some over a foot long, but there was no tinstone with them. A very few were doubly terminated. Crystals of lighter shade enclosing small prisms of two undetermined minerals were met with in some of the Torrington mines. Similar but larger crystals invested with crystallised cassiterite were found at The Gulf.

Water-worn pebbles were often seen in the deep leads, the colours being variable and clear, but they were of lighter hues than those of Torrington.

Morion.—This, the black variety of cairngorm, was found in fine crystals at Fielder's Hill (Torrington) accompanying wolfram.

Chalcedony.—Chalcedony occurs under the same conditions as agate. The mammillated forms were sometimes seen, but they were either of poor quality or small.

Citrine.—Odd pieces of the yellow quartz were found at Kingsgate, but they were of rather light colour. As water-worn pebbles of a darker, richer yellow, it was met with in the alluvial drift of Oban. Some were very clear stones, which would probably have been suitable for ornamental purposes, though somewhat light in colour. The more decided deeper tints were rare.

Digitized by Google

Eisenkiesel.—This ferruginous variety of quartz, containing a number of small white spherical patches of the same material, is found at Drake. It takes a good polish and forms a pretty deep-red ornamental stone.

Jasper.—This variety may often be seen as pebbles and boulders of various colours in the deep leads and river beds, most frequently in Cope's Creek (Tingha) and Copeton. Some varieties, red, yellow, and variegated are capable of receiving a good polish, but only the red has received much attention, and this has yielded fine ornamental stones of bright brick-red colour. It is sometimes seen *in situ* forming masses which on the surface seem to be separated, though of the same occurrence. A large reef of unusually good quality and deep red colour outcrops between the Armidale and Exmouth railway stations. This is capable of yielding large quantities of solid blocks which should be freer from cracks than usual, and probably suitable for ornamental purposes.

Rutile (TiO_2).

Rutile is frequently found in quartz with the cassiterite of the Tingha field and sometimes, though rarely, on adjacent fields. The three minerals are often closely connected, not merely as associates in the same drift, but together *in situ* and even intermixed. Rutile is enclosed in quartz as acicular and capillary crystals of various colours, white, gray, light yellow-brown to dark brown, red and green. There may be two or more colours present in the same stone. The Writer has seen white, red, and green crystals in very distinct colours close together in the same specimen.

The quartz containing these inclusions is nearly always found in loose amorphous lumps, any crystals having generally become water-worn or broken. It is met with in the deep leads underlying basalt and in surface drifts, but is difficult to find *in situ* as so much of the containing rock is covered with alluvium. Where the rock has been left bare after sluicing operations it has been seen forming ordinary, but short and bunchy, veins in the granite. Where the quartz does not reach across the fissure crystals may be seen facing each other in characteristic manner. Such occurrences containing rulite are, however, rarely seen ; it was some years before the Writer could find one.

Rutilated quartz is found in contact with tinstone in impregnations in granite, especially where the quartz is crystallised. Quite recently crystals of cassiterite were seen very intimately connected with quartzcrystals which contained much rutile. In one mine at Tingha a vein of solid tinstone was thickly impregnated with it without quartz, but such an occurrence was probably unique.

In some instances the crystals of rutile are isolated from each other and pass completely through the quartz, in others they pass through a portion only and then show their terminations. A third class contains the rutile as a tangled mass of fine hair-like crystals, which are, as a rule, confined to one side of the quartz, the other side being transparent and quite free from it, as if the rutile had been precipitated to the bottom of a clear solution.

The crystals may be separate and in no regular order, or in parallel position like a bundle of sticks, in very thin hair-like aggregations, or in wide flat crystals not unlike blades of grass.

Digitized by Google

1 INCH.

Fig. 1.—Quartz crystal, with etched lines, Hart's Tin Mine, Torrington.

Fig. 2.—Rutile (showing crystal terminations) in quartz, Tingha.

Digitized by Google

Digitized by Google

Rutile has been found near the Bismuth mine (Torrington) distributed through a quartz formation in small bunches. This was analysed by J. C. H. Mingaye and found to contain :—

H_2O	·48
Fe_2O_3	1·46
TiO_2	97·24
SiO_2	·72
CaO and MgO	absent
Specific gravity, 4·150.	99·90

Spinel.

Balas Ruby ($MgAl_2O_4$).—Occurs with sapphire at Sapphire (Inverell) as pretty rose to rose-red amorphous fragments and octahedral crystals. They are transparent and of fine colour and quality but too small for use as gems, possibly larger stones may be met with as the field is opened up.

It is also found in the Tumbarumba-Jingellic district in similar form and colour, but rather larger.

Pleonaste ($MgAl_2O_4$, with more or less of the magnesia replaced by ferrous and the alumina by ferric, oxide).

This mineral is common in the alluvial drifts of Copeton as an associate of the diamond. It is always in a much water-worn condition and very uniform in size, between an eighth and a quarter inch across; larger pieces are rarely found in that locality. It is much larger at Sapphire, and, like the stones generally of that field, it has suffered less from abrasion than that of other fields. The larger fragments resemble those from Anakie (Central Queensland) and might be suitable for gem purposes.

It is also met with in the tin drifts of Tingha in water-worn form and on the Inverell-Glen Innes road, where it is found both amorphous and in octahedral crystals. The colour of the mineral is black.

Titanic Iron [$(TiFe)_2O_3$, the proportions of Ti to Fe varying].

This mineral is subdivided into varieties according to composition, and in the absence of analyses the following occurrences are therefore placed under a general heading.

It is found in considerable quantity in many localities, generally as a fine black sand, or in water-worn grains resembling alluvial tinstone, with which it frequently occurs. It is present in the diamond drift of Copeton in similar form and in the alluvium of Sapphire (Inverell), but is there in larger and more angular fragments. Being a common associate of alluvial minerals it is very widely distributed as at Tingha, where it is found in large quantity.

Tungstite (WO_3).

Tungstite, the native tungstic trioxide in its pure state as a yellow powder, is a very rare mineral in this State. It was seen only at Fielder's Hill (Torrington), where it coated crystalline ferberite. Unless noticed *in situ* it is liable to escape detection, as it shakes off its base so readily.

A variety occurs at Kingsgate attached to masses of wolfram, from which it has been changed. Wolfram (ferberite?) is a very unusual occurrence with the molybdenite of this district, and this was the only deposit in which any chemical action of the kind was observed. The oxide was in the form

Digitized by Google

of a gray powder, more or less red in parts, and was perhaps identical with the hydrous ferric tungstate ($Fe_2O_3WO_36H_2O$). It was the only instance in which any appreciable change was seen in the wolfram anywhere, and was perhaps the result of chemical action by sulphuric acid resulting from the decomposition of pyrite, of which an usually large quantity was present. The molybdenite was closely associated but appeared to have been unaffected.

Wad ($H_2Mn_2O_5$, but variable).

Wad was seen in the Broken Hill lode with psilomelane and as a coating upon cerussite. Also in the Consols mine (Broken Hill) in vughs in limonite, which it partly filled, accompanied by pyrolusite. In each case it occurred as a black earthy mineral.

(*f*) SILICATES.

Actinolite[(Ca Mg Fe)SiO_3].

Green crystals of actinolite were met with in vughs in the granite at Slurry Gully (Tingha), accompanied by crystals of orthoclase and cairngorm. Crystals of the same type of a brown colour forming radiating groups were enclosed in very perfect quartz crystals in a siliceous formation which was being prospected for tin at Howell. Similar crystals, also in crystallised quartz, were found at Abingdon Station (Bundarra) of brown and green colours, both being present in some instances in the same crystal of quartz. Some of these, cut and polished, formed very pretty ornamental stones. In each of these occurrences the actinolite was in acicular crystals and in limited quantity.

Analcite ($Na_2Al_2Si_4O_{12} + 2\,Aq$).

Analcite is found in small colourless crystals with other zeolites in basalt at Ardglen. This occurrence has been examined and described by T. H. Smith.*

In a large number of shafts sunk through basalt, the writer has seen deposits of zeolites in two only. Much of the rock is dense and affords no spaces in which they could be formed. Such minerals are, however, more frequently seen in quarries in which the rock is opened over larger areas. In some of the shafts in the Northern district (Gilgai) advantage has been taken of the columnar structure of the basalt of that locality. By removing several of the columns, serviceable, safe, almost vertical shafts have been formed. The rock in these was not broken into, and so if any zeolites were present they would not be seen.

Australite (Composition variable).

In their occurrence these interesting objects seem to be confined to certain localities, and one of these is that portion of this State which is bounded by Bendemeer and Tingha and of less width, say 60 miles square. Omitting some of the outside occurrences this could be reduced by embracing the area between Uralla and Tingha, in which nearly all the stones were found, and which would be less than 50 miles square. A further reduction might be suggested owing to concentration in certain localities, as by far the largest number of stones were found within a radius of 4 miles of each of these towns.

Much alluvial mining work has been carried on in these localities and, in consequence, the discovery of the australites would be much more likely

* Rec Aus. Mus., 1924, Vol. XIV, No. 3, pp. 213-222.

Digitized by Google

Fig. 1.—Crystal of Native Bismuth, Kingsgate.

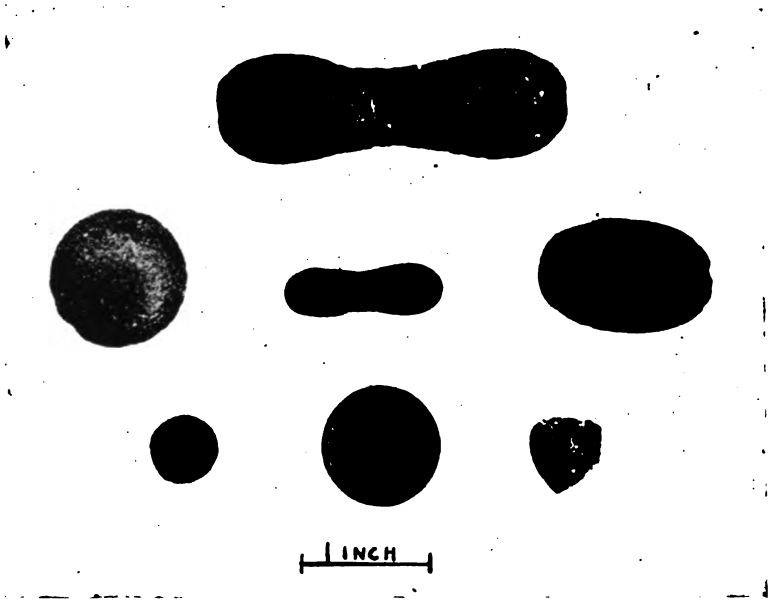


Fig. 2.—Australites—The first four from Tingha; others from Uralla.

Fig. 3.—Native Bismuth in Quartz, Kingsgate.

Digitized by Google

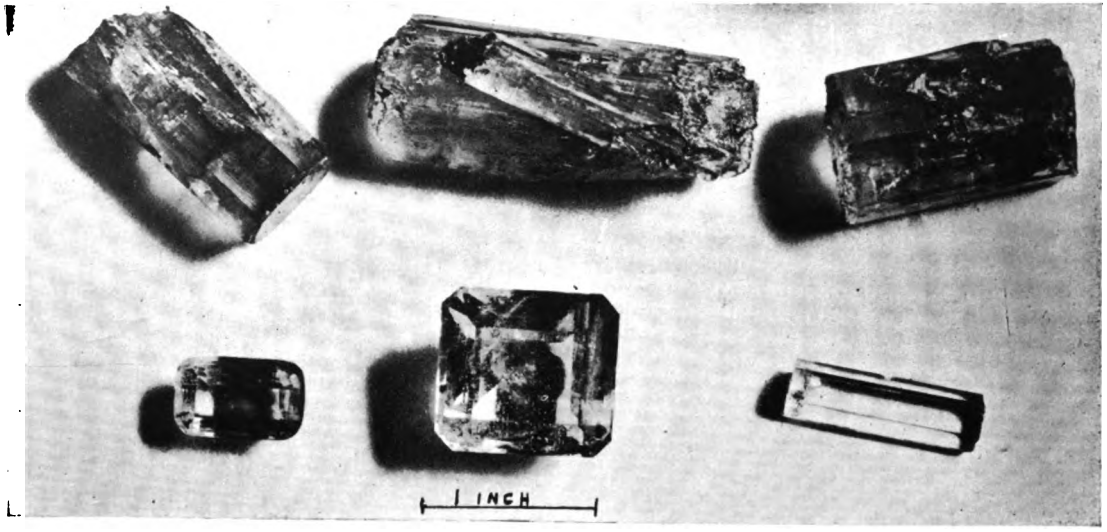


Fig. 1.—Beryl (crystals and two cut stones), Heffernan's Wolfram Mine, Torrington.

Digitized by Google

as a result of this than in ground that had not been disturbed. This, however, applies to other parts of the district where the same conditions exist, but in which no australites have been found. The only outside localities in which the writer has seen these stones are Watson's Creek (Bendemeer) and Mount Mitchell, both of which are embraced in the above areas, but only one stone was found in each place. There were of course many others with which the Writer had no connection, but what he saw would no doubt be representative of the general occurrence.

They were nearly all found on or near the surface, the deepest being 8 feet. Little importance can, however, be attached to records of depth in these localities owing to the changing surface levels due to tin sluicing operations. Reputed discoveries in the deep leads underlying basalt were investigated, but in no case could they be substantiated; it seems very improbable that such an occurrence has yet been seen.

The commonest form is the button shape, consisting of a central dome surrounded by a flat broad band, the whole forming a round (in rare cases oval) saucer-shaped, remarkably symmetrical object, showing very little variation either in size or form. This is the typical Uralla shape, and no other form is known to the writer from that district. Most of the stones had, however, lost a portion, or the whole of the outside rim. This type also formed a large proportion of those found at Tingha, but there they were always found imperfect, the rim having almost wholly been broken off. The next most common variety found at Tingha was the dumb-bell shape which was only seen in that locality. This varied from an inch to two and five-eighths of an inch in length. Two of oval and one of round basin shape were found here, one of the former being a very fine large stone.

All of these varieties were in a fairly good state of preservation except those with broken rims. The smaller ones were somewhat abraded, but as a whole they showed less rounding than those from Central Australia, perhaps because they had not been subjected to the same surface attrition.

Other localities in which they were seen were near Cockburn (South Australia-New South Wales border) where several large basin-shaped stones were found, and near the Day Dream mine (Barrier Ranges) of the oblong type.

Beryl ($Be_3Al_2Si_6O_{18}$).

The largest deposit of this mineral was in Heffernan's mine (Torrington), in which a number of very fine transparent light green crystals were found while prospecting for wolfram. There was but one deposit of them, and though operations were continued for some time after this had been exhausted no more were seen, though further small bunches of wolfram were found. The formation throughout presented very favourable features from a prospecting point of view, but for long distances contained no mineralisation of any kind.

The matrix which contained the beryls was about a foot wide and consisted of quartz, felspar, and black mica, similar to other occurrences which enclosed various minerals in this district. The beryls were embedded in parts of this matrix which were so decomposed as to be reduced to a white to yellow micaceous clayey mass; they also bore evidence of having been subjected to the same or similar chemical action.

Digitized by Google

This matrix has been classified as pegmatite; other occurrences of its class were smaller or much larger; each presented many minor differences from the others, yet all possessed a strong general resemblance and often contained bunches of wolfram, smaltite, or bismuth (native or oxidised), and sometimes beryl or topaz. These minerals were, however, very erratic in their occurrence; there might be odd crystals or patches along what was sometimes a joint in the middle of the mass.

Decomposition of the matrix was not uncommonly seen with detachment of the beryl and its occasional associates, all of which might be found in the same kind of clayey material. Many of the beryls had suffered greatly from corrosion, but the whole of them were not affected; chemical action had been concentrated at certain points, but this did not appear to have changed the other minerals except perhaps the wolfram, which was sometimes in a rather friable or altered condition, and the bismuth, in a more powdery form, but no two deposits presented quite the same features.

The crystals were all terminated though some were so corroded that the original termination had disappeared; a few had lost both ends through this cause and were deeply pitted or grooved for some distance along the prism. Those which were undamaged had flat ends, while a few exhibited parallel and zonal growths, the latter being well illustrated. The crystals from Heffernan's mine have been examined and described by Dr. C. Anderson, M.A.,* who has given much consideration to their etchings. They were analysed by J. C. H. Mingaye and found to contain :—

	No. 1.	No. 2.
SiO_2	66·08	64·70
Al_2O_3	19·86	22·22
BeO	12·96	11·84
FeO	·30	·37
MnO	trace	trace
MgO	trace	·04
Na_2O	·43	·24
K_2O	nil	·13
Li_2O	Strong spectroscopic traces.	
SrO	,,	,, ,,
H_2O	·58	·60
CaO, P_2O_5, Cr_2O_3, V_2O_3	nil	nil
	100·21	100·14
Specific gravity	2·661	2·666

The corroded crystals referred to were all from Heffernan's mine or from Tungsten, which are about 2 miles apart. Beyond this, other beryl occurrences showed no alteration. As at The Gulf, where so many of the quartz crystals were pitted, the corrosive action seemed to have been confined to certain limited areas. This, however, does not apply to the mineral-bearing pegmatites which were seen to be altered over a much greater area. Dr. Anderson attributes the etching to the action of alkaline solutions. It seems probable that whatever the cause may have been, it was also responsible for the decomposition of the enclosing rock immediately enclosing the crystals.

* Rec. Aust. Mus., 1920, Vol. XIII, No. 1, pp. 1–3.

Digitized by Google

Digitized by Google

Fig. 1.—Beryl crystal in Native Bismuth, Bismuth Mine, Torrington.

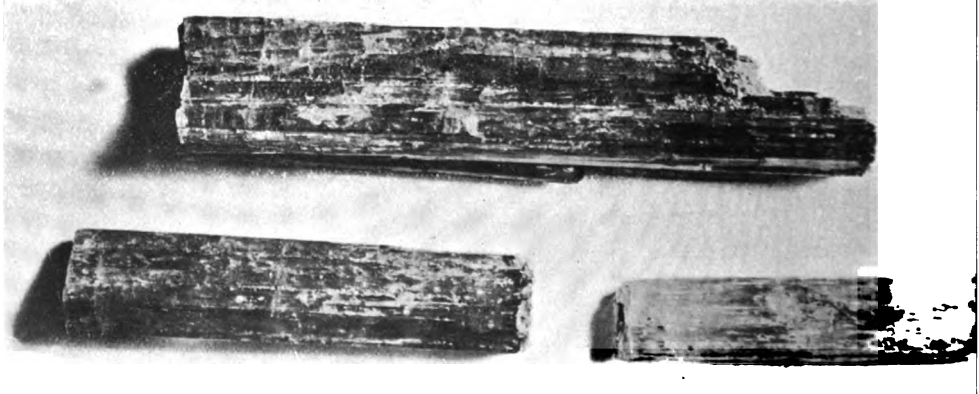


Fig. 2.—Beryl crystals, The Gulf.

Digitized by Google

The most perfect of the beryls were small, light green, transparent prisms, which were found near the Bismuth mine (Torrington). These had flat terminations and were of a very fine quality. Prisms of similar type were met with at The Gulf, but they were lighter in colour and opaque.

What was perhaps the finest deposit of beryls, excepting Heffernan's, was enclosed in a soft micaceous rock 3 miles west of The Gulf. They were mostly light green, but among them were smaller light blue crystals, a most unusual colour. Some were nearly 4 inches long, the terminations being uneven and ragged, the larger prisms being deeply striated longitudinally. In quality and size they were inferior to Heffernan's; being rather flawed they were unsuitable for gem purposes, but they were of a distinct type. Some of the smaller crystals had been fractured *in situ* and naturally rejoined with a slight amount of displacement, like a broken limb improperly set.

A few crystals were seen at Wunglebong (Tenterfield) in the molybdenite pipes, some enclosed in bismuthinite, but they were small and inferior. In small slender almost colourless prisms, they were common in the Emerald mine (Emmaville).

About midway between Emmaville and The Gulf an opaque variety was associated with wolfram, and specimens were seen in which the two minerals were crystallised and intergrown. Three fine crystals of light transparent green shade were found in the Bismuth mine embedded in native bismuth. These were enclosed in a large mass of pegmatite containing an unusual quantity of the lithia-bearing biotite of this district.

Crystals found in the alluvium in different parts of the Torrington field varied according to locality. There were yellow prisms unusually long compared to their diameter; one doubly terminated crystal was seen with flat ends, the attachment to the rock having apparently been at one corner. Another type was a fine green unusually clear prism with rounded termination showing slight projection of smaller crystals around the periphery of the termination and perhaps indicating parallel growth. Another was of the Heffernan type with flat termination. They showed little or no damage through attrition, so it is probable that occurrences of this interesting mineral as yet unknown may exist in the localities in which they were found.

Many of the crystals from Heffernan's mine were of gem quality, and some beautiful lustrous aquamarines were cut from them. The Torrington stones generally were of superior quality and occasionally one has been seen which almost equalled the emerald in richness of colour. It was not always the most likely looking crystal which yielded the best gem; some which seemed to possess all the essential qualities required proved to be lustreless when polished.

Biotite [$(K_2Al_4(FeMg)_{12}Si_6O_{34})$.] Magnesia-iron mica, part of the Al_2O_3 being replaced by Fe_2O_3 and FeO and MgO existing among the protoxide bases.

Biotite is found at Torrington (and less conspicuously in other localities) as a constituent of masses of pegmatite which appear to have an essential connection with some of the tungsten-bismuth-beryl deposits of that

Digitized by Google

district. It is therefore of more than ordinary interest, especially as contains a small amount of lithia. It has been analysed by H. P. Whi who found it to contain the following :—

SiO_2	36·76
Al_2O_3	19·68
Fe_2O_3	4·50
FeO	21·24
MgO	2·00
Na_2O	1·29
K_2O	9·31
H_2O+	1·64
H_2O-	·50
TiO_2	·11
P_2O_5	·03
Cl	·29
F	3·30
BaO	·01
MnO	·41
Li_2O	·78
SO_3, CO_2, ZrO_2, V_2O_5, Cr_2O_3, NiO, SrO	Not present.
	101·85
O, F, Cl	1·44
	100·41

About 1 per cent. topaz estimated to be present and is included in analysis.

It occurs with the felspar and quartz in masses of black flakes, whic often an inch or more square. Exceptional blocks have been seen contai lustrous sheets about 3 to 4 inches square.

Chabasite [$(HK)_2\ CaAl_2Si_5O_{15} + 6H_2O$).]

Some beautifully perfect groups of colourless rhombohedral crysta chabasite were found in sinking a shaft through amygdaloidal basalt 6 m west of Emmaville. With them were clusters of aragonite crystals.

Chloropal ($Fe_2Si_3O_9 + 5H_2O$).

Chloropal was met with in yellow to greenish-yellow amorphous in bunches in the Attunga copper mine (Attunga). Upon analysis by J. Mingaye it was found to contain the following :—

SiO_2	73·26
Al_2O_3	·50
Fe_2O_3	14·90
FeO	·27
MgO	·24
CaO	1·22
Na_2O	·28
K_2O	·13
H_2O+	4·84
H_2O-	4·30
CuO	·12
MnO	·01
P_2O_5	trace
CO_2, TiO_2, BaO, SrO	nil
	100·27

Specific gravity, 2·242.

Digitized by Google

To face page 66.

PLATE XIX.

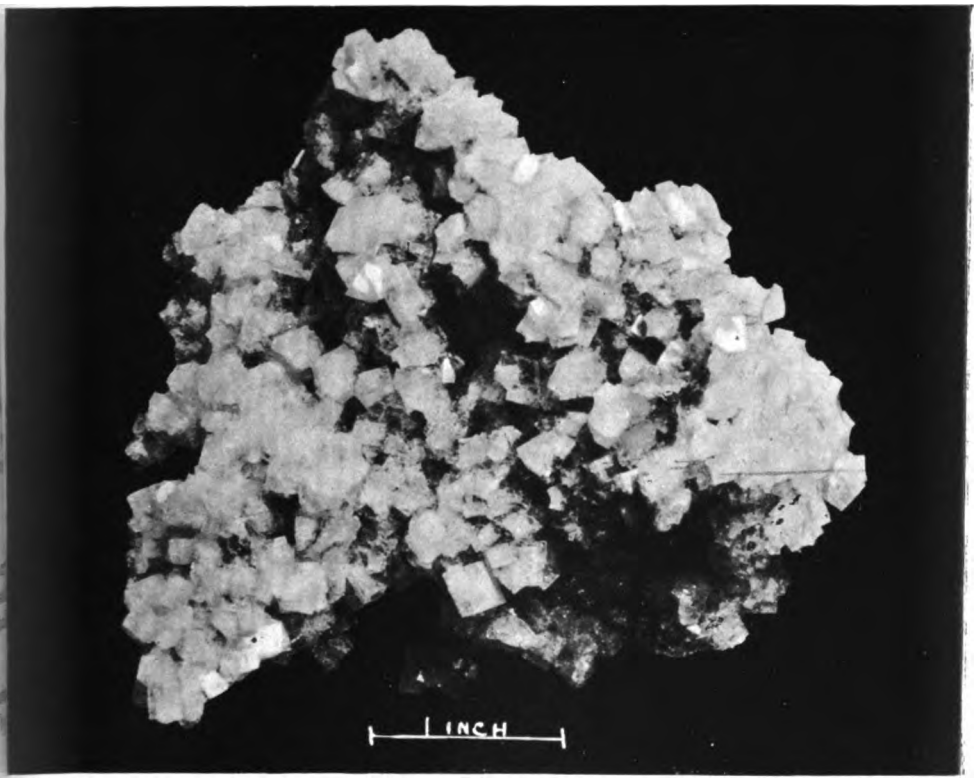


Fig. 1.—Chabasite, Reidy's Shaft, Emmaville.

Digitized by Google

Digitized by Google

Chrysocolla ($CuOSiO_2 + 2H_2O$).

This mineral was found in several of the Broken Hill mines. It usually occurred in amorphous bunches, but botryoidal forms also were seen, each kind sometimes showing partial alteration to malachite. It often contained crystalline patches of cerussite, with films of embolite, or cuprite with some malachite. It was generally enclosed in cerussite, but did not exist in appreciable quantity. In colour, which was a very distinctive turquoise blue, it resembled no other mineral on the field. With its inclusions and associates it was always interesting, and was perhaps the most attractive of the non-crystallised minerals of the Broken Hill lode. A sample from Block 14 mine obtained in recent years was partly analysed by J. C. H. Mingaye, who found it to contain the following:—

CuO	36·04
PbO	6·51
ZnO	2·44
Fe_2O_3	·54
Al_2O_3	trace
SiO_2	30·78
H_2O	18·60
	94·91

With some CO_2 and a little MgO and CaO. Minute trace of Cl. Little Ag. No P_2O_5 or SO_3 present.

The early discoveries of this mineral at Broken Hill were found to contain a small amount of alumina. Some varieties gradually faded on exposure to the light, and appeared to differ in some respects from the chrysocolla of normal type.

Unusually large quantities were met with in veins near the surface in the lode of the Caroline mine (Tottenham). It formed the principal ore in that part of the mine, though it was associated with malachite, but it continued only a short distance downwards. Of a bluish-green colour, it was unusually pure and free from mixture with other minerals.

In very small quantity it is sometimes found in other lodes, not necessarily those of copper, in which ores of this metal may occur.

Emerald ($Be_3Al_2Si_6O_{18}$).

The mine in which this gem was found is known to the Writer, but as it had been closed for many years he was unable to enter the workings. Apparently the emerald was associated with pegmatite dykes resembling those of Torrington, which contained the beryl there. All of these occurrences were not far distant from each other.

Most of the crystals were slender prisms of beryl of very pale green colour, inferior to the larger varieties of Torrington. There were, however, well formed crystals of deeper, more emerald green, some of which because of their superior quality were used in jewellery in their natural form. These were capable of yielding gems of rich colour, freer from blemishes than is usually seen in this stone. Crystals of lighter colour, but still superior in this respect to the ordinary beryl, were seen penetrating fluorite. Many were embedded in quartz, or in felspar or black mica, very typical of some of the beryl occurrences of Torrington.

Topaz in small colourless crystals with mispickel and some crystallised cassiterite were associated minerals.

Digitized by Google

Garnet (Composition variable).

Though garnet is of common occurrence, little has been done to classify the different varieties, and therefore many exist to which no specific name can at the moment be given. Among these are small amorphous dark red but transparent stones which are found in the alluvium at Poolamacca (Barrier Ranges). They are rather small but of good quality, and have been used for gem purposes. They are probably almandine.

A well crystallised grayish-brown opaque variety from the Duckmaloi River (Oberon) is found in masses. It has been proved to be a lime-iron variety. It resembles and is perhaps identical with andradite.

Small red crystals occur in quantity in a black micaceous matrix in parts of the Tingha-Copeton district.

Rose coloured, much fractured, opaque crystals were seen in mica schist in the Silver Crest mine (Silverton) which were coated with silver chloride.

Small red-brown somewhat decomposed imperfect crystals and fragments are numerous in the diamond drift underlying basalt at Copeton. Quantities are also found with the molybdenite deposits of Jingera (Whipstick).

The common form of crystal is the rhombic-dodecahedron or its modifications.

Almandine ($Fe_3Al_2Si_3O_{12}$). A rose-red amorphous variety, is of common occurrence in the gneiss of the Broken Hill district, and is referred to in the chapter upon the minerals of the Broken Hill lode. The following is a further analysis by J. C. H. Mingaye of a sample from near the North mine :—

SiO_2	38·84
Al_2O_3	19·75
Fe_2O_3	12·20
FeO	22·20
MnO	·97
MgO	3·87
CaO	1·18
Undetermined	·99
Specific gravity, 4·067.	100·00

Good but opaque crystals may be found near The Pinnacles (Barrier Ranges) strewn over the surface in a shallow water-course where they have been washed out of the decomposing schist. Some interesting crystals, single and groups, can be procured of a dark red colour, the common form being the rhombic-dodecahedron.

It is also seen as small water-worn fragments in the Macquarie River with zircon and sapphire.

Grossularite (3 CaO, Al_2O_3, 3 SiO_2). Small colourless dodecahedral crystals of grossularite were found in fissures in igneous rock at Bowling Alley Point. These have been described and analysed by T. H. Smith,* who gives their composition as follows :—

SiO_2	39·96
Al_2O_3	23·21
Fe_2O_3	·68
FeO	·95
MgO	·53
CaO	35·04
MnO	trace
	100·37

* Rec. Aust. Mus., 1923, Vol. XIV, No. 2. pp. 101-4.

Digitized by Google

Digitized by Google

Fig. 1.—Spessartite crystal, Block 14 Mine, Broken Hill.

Fig. 2.—Spessartite crystals in Galena, Junction North Mine, Broken Hill.

Digitized by Google

Spessartite [$(MnFe)_3$ $(Al_2Si_3O_{12})$]. Very fine crystallisations of spessartite are seen in the Broken Hill lode. It was one of the very early minerals which was found at shallow levels enclosed in cerussite, and often associated with embolite. The shallow occurrences were much fractured but still in good single crystals or groups. Though the larger crystals were imperfect and generally broken when found there were smaller dodecahedral crystals which were entire. All possessed very smooth polished faces, and their colour, reddish-brown to light brown, was much lighter than the unaltered crystals found in the sulphide ores. The fracturing was apparently due to chemical changes in foreign minerals which could often be seen enclosed in them, particularly cerussite, which had been changed from galena.

In the sulphide zone spessartite occurs in inter-crystallised groups and as single and compound crystals. They may contain galena or more rarely other sulphides and show internal fractures similar, but less pronounced, to those seen in higher levels. The crystals when free from cracks are rich red-brown to rose red. The finer transparent kinds are lustrous and exhibit bright yellow to red flashes, but except the very small crystals they are generally too defective for gem purposes. It is possible, however, to find among them some that yield gems of good lustre and rich appearance, not unlike the hyacinth of New England. When enclosed entirely in galena they appear to be superior in quality and form, but some are much corroded. Associated with them are pink or gray fluorite with or without blende, and occasionally chalcopyrite and apatite.

Masses, large or small, of this mineral composed of crystalline grains (garnet sandstone) were of common occurrence through this lode, and were often found to contain important impregnations of embolite and native silver. An analysis of the crystal form is given with further reference to this mineral in the chapter upon the minerals of this lode generally, and for comparison the following analysis, which is also by H. P. White, will show the composition of the "sandstone" in Block 10 mine:—

SiO_2	36·52
Al_2O_3	12·57
Fe_2O_3	7·00
FeO	6·66
MnO	29·96
MgO	·08
CaO	6·06
Na_2O	·20
K_2O	·14
H_2O+	·22
H_2O-	·24
CO_2	·02
TiO_2	·15
S	·04
SO_3	·11
PbO	·15
P_2O_5	trace
Cl	trace
F	·18
	100·30
Less O equivalent to F and S	·09
	100·21

Specific gravity, 4·167.

Digitized by Google

Ouvarovite ($Ca_3Cr_2Si_3O_{12}$).—This rare mineral was found in the Phœnix, Perseverance, and Reform gold-mines of Lucknow at a depth of 60, 130, and 200 feet respectively, where in following the auriferous formation a quantity of decomposing siliceous-ferruginous material was met with containing a number of bright green specks. These were separated by panning off the lighter material; the concentrates consisted of small dodecahedral crystals of this mineral. Investigation showed that the original matrix was quartz, which on becoming decomposed, either wholly or partly, had set the garnet free in an undamaged condition. The mineral was subsequently traced to its source in deeper levels and there found to be disseminated through a quartz vein which adjoined the auriferous joint that was being followed.

An analogous mineral from Paling Yard, near Barraba, occurs in chromite. This particular deposit of chromite was much slickensided, and in the movement-planes was an encrustation of a highly polished dark apple-green mineral which was analysed by J. C. H. Mingaye, whose results are now given. It is interesting to compare them with the mean of three analyses of ouvarovite from the Ural Mountains as recorded by Dana*.

	From Barraba.	From Ural Mountains.
Cr_2O_3	21·44	22·61
Al_2O_3	9·22	5·94
Fe_2O_3 (contains FeO)	9·00	2·20
CaO	17·26	31·76
MgO	11·19	1·32
K_2O	trace	.....
Na_2O	trace	.....
SiO_2	27·28	36·54
H_2O	4·96	.....
	100·35	100·37
Specific gravity	3·465	3·465 (mean.)

The Barraba sample contained a small amount of chrome iron ore. If it be assumed that a portion of the lime had been replaced by magnesia, the analyses show much resemblance. The specific gravity is exactly the same. The magnesia may be accounted for by the presence of serpentine through portions of the chromite.

The mineral occurs only in joints of the chromite, but not in all of them, and is evidently an alteration product due to conditions arising from earth movements. That the pressure was intense is indicated by the very smooth polished slabs. A number of specimens were examined, the quantity of material was fairly plentiful, but in no case could any trace of crystallisation be detected.

Halloysite ($Al_2Si_2O_7 + 4H_2O$).

Halloysite occurs in gray amorphous bodies in alunite at Bullah Delah, also in yellow-green masses in the Macquarie Ranges.

The kaolin of the Broken Hill lode according to Professor Austin F. Rogers† is halloysite.

Kaolinite ($Al_2Si_2O_5 + 2H_2O$).

Large masses of kaolinite occurred in the Broken Hill lode often impregnated with iodyrite and embolite as films and plates, the embolite also as coralloidal veins and bunches. Slickensides were frequent and in the joints the silver minerals were often partly changed to metallic silver. The latter

* "A System of Mineralogy," 1868, p. 270. † "The Journal of Geology," 1917, p. 535.

Digitized by Google

was present in dendritic forms and films, sometimes as plates. Crystals of spessartite were thickly distributed through the mass in some localities.

The kaolinite was generally white and earthy, but in parts it was black or reddish through impregnation of manganese or iron oxides. According to Professor Rogers* it is not really kaolin, but halloysite.

It is a mineral of general occurrence; immense quantities have been developed at Home Rule and Tichborne.

Knebelite $(FeMn)_2SiO_2$.

Knebelite is a rare mineral which has been found in the Broken Hill district. It was in the massive form of dark brown colour.

Muscovite $(K_2H_4Al_6Si_6O_{24}) + (H_8Si_{10}O_{24})$.

Sheets of muscovite of rose tint have been found in the South and Junction mines (Broken Hill), some measuring 6 by 4 inches.

At Lionsville an outcrop unopened and much weathered shows flakes measuring 4 by 2 inches, probably larger specimens could be obtained if the deposit was developed.

The only crystallised variety seen was at Dundee, where bunches of small hexagonal plates were associated with cassiterite crystals. Quartz crystals also formed a part of this occurrence.

Natrolite $(Na_2Al_2Si_3O_{10} + 2H_2O)$.

Pretty radiating clusters of delicate white acicular crystals of natrolite were seen in the amygdaloidal basalt of the Elsmore-Newstead Junction shaft (Elsmore). They were associated with other zeolites, which, however, were too much decomposed for identification. The natrolite was also destroyed in places, but some of the cavities containing it had escaped and with brewnerite and aragonite it was then almost unaltered.

It may be seen on the surface filling similar vesicles in basalt in the town of Inverell with other zeolites which are too much weathered to identify.

It was also met with in the railway quarry at Ardglen in yellowish-white radiating tufts associated with analcite and fine crystals of calcite in fissures in basalt. This occurrence has been described by T. H. Smith.†

In the basalt of the old State quarry at Kiama acicular and compact radiating groups of crystals may be found of pink to red colours.

Orthoclase $(K_2Al_2Si_6O_{16})$.

Orthoclase is of such universal occurrence that only those deposits which by reason of their crystallisation or other features are of special interest will be referred to. The finest crystals were from Tingha, where they were found on or near the surface in joints in granite. They were fairly perfect and symmetrical with smooth surfaces, the crystals being simple and twinned. Manebach and Baveno types were seen, and also combinations of the two forms. It is probable that if the deposit, which is 3 miles south-south-east of the Tingha post office, was prospected, other fine examples could be found as it has been opened to a very short distance below the surface. Similar forms were met with elsewhere in the same locality, but they were somewhat corroded. On the opposite side of Tingha groups of smaller crystals were found associated with quartz crystals, the whole being dusted over with small green acicular crystals of actinolite.

* "The Journal of Geology," 1917, p. 585. † Rec. Aust. Mus., 1924, Vol. XIV, No. 3, pp 213-222.

Digitized by Google

Groups of partial crystals in parallel growth penetrated by quartz crystals, giving the mass a graphic structure were seen at Oban. These crystals, which were found on the surface, have a decided green tint.

The most perfect crystals, small but numerous, were found at Tungsten (Torrington), where they may still be seen weathering out of a heap of porphyritic rock adjacent to the old wolfram workings, and, incidentally, near where an interesting occurrence of light blue topaz may be seen *in situ*. These crystals are of simple prismatic habit with some very perfect Carlsbad and Manebach twins. The crystals were isolated in the matrix and are therefore usually complete, unlike the larger types which have been attached to the containing rock. With them are numbers of small doubly terminated quartz crystals without prism.

Crystals of the Carlsbad with other types were found loose on the surface about 10 miles east of Wellington. They had suffered through exposure; others could be seen in the rock near by, but they could not be extracted intact.

A few fine groups of crystals were associated with crystallised scheelite at Moonbi. This occurrence was the more interesting owing to the combination of good crystals of each mineral, but it is doubtful if any of it was preserved.

This mineral was found in the Broken Hill lode of an unusual green colour, quite distinct from the blue-green of microcline, with which it has been confused. Professor Beck* states that it contains tiny inclusions of a light brown liquid, often with moveable gas bubbles, and no character could be found to identify it with that mineral; no metallic compounds could be found which might be regarded as pigments, and its green colour disappears at a red heat. An orthoclase of similar colour at Anneberg was found to assume its colouring only on exposure to the open air. When first seen at the South mine it was noticed that a quantity which had been exposed to the atmosphere for some time was of a richer and deeper green than any that was freshly broken underground, so it is probable it resembles the Anneberg variety in this respect. It occurred in quantity with the sulphide ores.

The following analyses have been made of occurrences referred to above, the first by W. G. Stone, the others by J. C. H. Mingaye :—

	Wellington.	Wellington.	Tingha.
SiO_2	65·40	65·54	66·94
Al_2O_3	19·01	16·68†	19·56
Fe_2O_3	·05	1·14	1·30
FeO	·32	·27	·18
MgO	·16	·38	·11
CaO	·29	·86	·30
Na_2O	2·94	3·27	9·76
K_2O	11·10	11·53	·73
H_2O+	·12	·42	·39
H_2O-	·09		·83
TiO_2	·12	.....	.....
P_2O_5	·03	.....	·03
BaO	·64	trace	trace
SrO	trace	trace	trace
CO_2	.....	·01	·03
SO_3	.....	.....	·01
MnO	.....	.....	·04
	100·27	100·10	100·21
Specific gravity	2·579	(not recorded)	2·568

† Including any MnO, TiO_2, and P_2O_5 present.

* Rec. Geol. Survey, N.S.W., 1900, Vol. VII, Pt. 1, p. 21.

Digitized by Google

Pseudophite [5(MgFe)O, $(AlFeCr)_2O_3$, 3 SiO_2, 4 H_2O.]

Pseudophite, an amorphous green mineral which was long regarded as precious serpentine, occurs in that rock at Hanging Rock (Nundle). It is translucent, of uniform colour, takes a good polish, and crushes to an unctuous white powder. Fragments of chromite may be seen enclosed in some of it. It has been described and analysed by Professor Benson, B.A., B.Sc.,* who found it to contain the following :—

SiO_2	33·43
Al_2O_3	16·86
Fe_2O_3	·55
FeO	4·18
MgO	33·71
H_2O+	12·47
H_2O-	·13
TiO_2	·05
Cr_2O_3	·08
Ni, CoO	·03
MnO	·22
	101·71

Rhodonite ($MnSiO_3$).

Rhodonite is found as crystals and solid masses in the Broken Hill lode with galena and other sulphides. It did not occur in the shallower levels like spessartite, and was therefore not recognised until a considerable time later. Between the upper levels, where so much stalactitic manganese oxide had been deposited, and the sulphide zone in which the rhodonite occurs, there was a great paucity of manganese minerals, and those which were seen in this large area represented a limited quantity of material.

The crystals are deep red, prismatic and tabular, with bright faces and rounded edges, showing the effects of corrosion similar to those of spessartite. The massive type is compact or granular and more brownish-red in colour, and is closely associated with calcite, galena, and blende.

A number of analyses have been made, which show rather discordant results owing to the partial replacement of the MnO by CaO and FeO. The following results were obtained by J. C. H. Mingaye and H. P. White respectively :—

	From South mine.	From British mine.
SiO_2	46·52	45·56
MnO	33·84	35·77
FeO	9·45	12·51
Fe_2O_3	.....	·60
Al_2O_3	·44	1·70
CaO	8·74	3·50
MgO	·62	trace
ZnO	trace	.....
CO_2	trace	.....
PbS	.....	trace
H_2O	·30	·38
	99·91	100·02

Rhodonite from Broken Hill has been described by Professor Beck† and by Dr. C. Anderson.‡

* Proc. Linnean Soc., N.S.W., 1913, Vol. XXXVIII, Pt. 4, pp. 681, 682 and 705.
† Rec. Geol. Survey, N S.W., 1900, Vol. VII, Pt. 1, pp. 20-28.
‡ Rec. Aust. Mus., 1908, Vol. VII, No. 2, pp. 129-133.

Digitized by Google

Irregular bunches of this mineral of a pink colour and massive type occur near Copeton. It is coated with the oxide of manganese, into which it is being changed. A similar pink variety of superior quality was found at Bendemeer.

A mineral discovered in recent years in the Broken Hill lode in very dark-green cleavable masses has been provisionally described as green rhodonite. It is intimately associated with the sulphides of the lode and its classification is very doubtful. It is now being investigated.

Rœpperite [$2(MnFeZnMg)OSiO_2$.]

An iron-manganese-zinc chrysolite which was met with in the Junction North and Block 14 mines (Broken Hill). It occurred in amorphous masses in contact with the sulphide ore and was of reddish-brown to gray colour. On being analysed it was found to contain the following :—

MgO	1·83
FeO	22·41
MnO	36·27
ZnO	8·20
SiO_2	29·50
	98·21

Specific gravity, 4·08.

Serpentine ($Mg_3Si_2O_7 + 2H_2O$).

Good examples of the fibrous variety of serpentine of light-gray and gray-green shades of colour, representing different types, were seen in the Reform mine (Lucknow) near the auriferous contact. Some of these were bent or broken, while others were highly polished over large surfaces through earth movements. Replacement by calcite had occurred; in places nearly the whole of the serpentine had been altered, and some interesting pseudomorphs were seen.

It occurs as green coarsely fibrous veins associated with gray granular steatite and other magnesian minerals at Rockwell Paddock (Broken Hill). In similar olive green deposits it is associated with chrysotile at Wood's Reef (Barraba).

Chrysotile.—Though this variety of serpentine is met with in quantity in several parts of the State, the fine asbestiform kinds are rather uncommon; they are never equal in length of fibre and quality to the beautiful silky varieties found beyond the State.

Large quantities of serpentine were treated at Wood's Reef in recent years for the extraction of the fibrous portions which were commercially valuable. The rock as mined was crushed, which had the effect of separating the fibrous parts; the whole of the crushed material was then carried over shaking sieves, through which the finer and useless particles passed. From the remainder the silky portion was separated by being drawn upwards by suction, the residue being waste rock.

The chrysotile occurred through the serpentine as veins of very light olive-green silky or fibrous material. The fibres comprising the veins were generally arranged at right angles to the enclosing walls and were rarely longer than an inch, the bulk of them being much shorter. Several veins might exist within a short distance of each other, but most frequently it was not so, and in order to obtain a small amount of marketable material it was then necessary to treat a large quantity of valueless rock. Associated with this

Digitized by Google

mineral were patches and nodules of magnesite, some of which enclosed silky fibrous veins of it, and little bunches of hyalite, both however in small quantity.

Chrysotile of a coarser and less silky nature, though the fibres were longer, was present in the Rockwell Paddock occurrence. Talc and steatite were also seen in association, but operations were not advanced beyond the prospecting stage.

Patches of the silky variety were present in the serpentine at Lucknow following its junction with andesite.

Marmolite.—The best varieties of marmolite were from Gundagai, where they were found of a deep green colour enclosing films of free gold.

Picrolite.—In hard green-gray fibrous patches this variety was met with in the serpentine at Wood's Reef. The blades were not easily separable. It was also seen at Lucknow in masses with a very splintery cleavage, and at Rockwell Paddock, where the fibres were much longer and of a softer nature.

Smithsonite ($Zn_2SiO_4 + H_2O$).

This mineral was of very rare occurrence in the Broken Hill lode, where it was seen in small radiating clusters of transparent colourless crystals upon crystallised cerussite. As in the case of campylite, only two specimens of it were known to the Writer.

Stilbite ($H_4CaAl_2Si_6O_{18}+4H_2O$).

A number of very fine groups of light red-brown tabular crystals of this mineral (?) were found in basalt on Garawilla Station, near Coonabarabran. These have been analysed by J. C. H. Mingaye, with the following results :—

Si_2O	57·92
Al_2O_3	14·84
FeO	·45
MgO	·31
CaO	7·68
Na_2O	·55
K_2O	·16
TiO_2	·01
MnO	·02
H_2O+	16·01
H_2O-	2·37
Specific gravity, 2·154.	100·32

Very perfect but smaller clusters of tabular sheaf-like crystals of stilbite of a light brown colour were seen at the 500-feet level of the South mine (Broken Hill) in 1891. The quantity, however, was very limited.

Stilpnomelane [$(FeMg)_2(Fe_2Al_2)Si_5O_{15} + 3H_2O$.]

This mineral was found in streaks enclosed in siderite in the Consols mine (Broken Hill). It was amorphous and shining black in colour. There was but one occurrence of it. Upon analysis it was found to contain the following :—

FeO	35·82
Al_2O_3	7·30
SiO_2	37·63
CaO	2·61
MgO	1·90
H_2O	14·50
Specific gravity, 2·7; hardness, 3–4.	99·76

Digitized by Google

Tachylite (FeO, MgO, CaO, Na_2O, Al_2O_3 SiO_2+2H_2O, but variable).

Tachylite occurs as a crust on basalt, but is more often seen as loose fragments in the alluvium. It has been found in several localities in the Northern district of black, gray-black or bluish colour which through long exposure has aquired a definite gray-blue tarnish. It is often spherulitic in structure, the spherules which vary from pin-head size to half an inch or over in width, sometimes standing out in relief through the weathering down of the intervening and less resistant mass. Good examples were found in the Tingha-Inverell area.

Talc ($H_2Mg_3Si_4O_{12}$).

In light greenish foliated veins talc was met with in steatite in the serpentine of Rockwell Paddock (Broken Hill). The quantity available was small, but at the time it was seen the deposit in which it occurred had hardly been opened.

Steatite—This variety was found in the same body of serpentine in coarse gray granular masses associated with talc and chrysotile.

Topaz [$5(Al_2)SiO_5 + (Al_2)SiF_{10}$]

This mineral has been found in the New England district of the highest quality, but it has never been appreciated as it deserved, perhaps because its existence as it really is has not been fully known. The clear transparent stones, either crystals or pebbles, which are not uncommon, yield gems of great beauty and the various shades of light blue and yellow serve but to intensify their brilliance. The largest stones from Oban form particularly high-class gems; they are flawless, beautifully lustrous and perfect in every respect. Like several other interesting minerals which at one time were rather plentiful, they have become rare, and well developed crystals are now seldom met with. This is not due so much to exhaustion of the supply, as that there is less prospecting in localities in which they are found.

Very fine water-worn pebbles, some almost spherical, and crystals with the angles more or less abraded, were formerly met with in some quantity in the Oban-Mitchell River district. The stones were generally transparent, colourless to light blue and rarely of very pale brown tints, all capable of receiving a fine polish.

Smaller stones and better crystals, because less abraded, were almost common at Blatherarm (Torrington) where, as at Oban, they were found in the alluvium. Some of the most perfect forms were obtained at Tungsten where they were enclosed in pegmatite with beryl and bismuth oxide. They were of a light sherry tint, an unusual colour in this district. The associated beryls were very much corroded, but the topaz was not affected in this respect except in being detached from the containing rock. There were also smaller, colourless crystals in the vicinity in similar rock; all had very perfect terminations.

Fine colourless crystals were found with emerald in the Emerald mine (Emmaville), and with crystals of ferberite and quartz at Fielder's Hill (Torrington.)

Though much of the topaz is found in pegmatite veins it is also disseminated through greisen as a constituent of this rock. It may be seen on the surface in light blue patches at Hawkins' Hill (Tungsten) in good quantity. It is probably from such occurrences that the water-worn more or less opaque

Digitized by Google

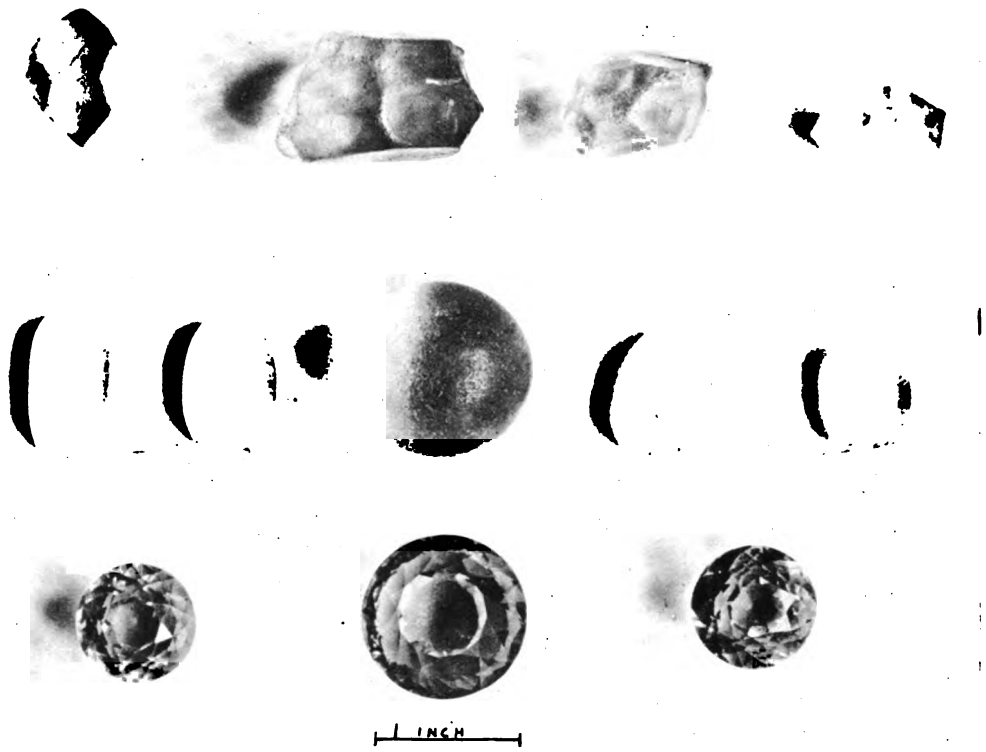


Fig. 1.—Topaz (8 cut stones), from Oban and Torrington.

Digitized by Google

Digitized by Google

variety which was rather common in the alluvium of the district, had been derived. In the rock it appears to be rarely crystallised, and then only in rough, unpolished, unterminated prisms. The perfect crystals are in the joints, or near them, and in vughs.

Water-worn stones are met with in the alluvium where tin-mining is carried on, particularly at Torrington, Tingha, Copeton, Elsmore, and Oban, in deep leads or surface drifts. They are often of good quality; some of the small unprepossessing pebbles have yeilded good gems. Rounded pebbles found on the surface at Lightning Ridge, though rather small, have been cut to great advantage as they show similar lustre.

Associated minerals *in situ* are quartz, cairngorm, beryl, ferberite, bismuth (native and oxide), smaltite, and fluorite.

Tourmaline.

(Composition complex $= \dot{R}_3(\dot{R}_6\dot{R})SiO_5 - \dot{R} = HKNaLi - \dot{R} = Mg$ (Ca)FeMn$-\dot{R} = Al_2Be_2$).

The occurrence of tourmaline is very general in the diamond drift of Copeton in slender prisms up to an inch long, all very much water-worn and denuded of any crystallised terminations they may have had. Where they occur on the surface, as in the drift of the Alfredamia mine, they are larger and rougher without the polish of those found under the basalt. Short stout crystals 2 inches or more in diameter have been seen detached on the surface, but they are not common.

A translucent variety occurred in the Copeton mines, rounded and almost spherical like pleonaste, and rather smaller than peas. These are said to have been cut for gem purposes with pleasing effect, but as they are of various shades of brown they could not compare with the brighter coloured varieties of this mineral found beyond this State.

Terminated crystals showing little evidence of attrition were found at Howell, but neither these nor any of the others were seen *in situ* in the Copeton-Tingha-Howell district.

A large bunch of cairngorm crystals containing tourmaline was met with in searching for tinstone on Hart's mine (Torrington). The crystals of each were well developed with some good terminations, single and double. The tourmaline occurred as inclusions, partial penetrations, or attached wholly on the outside of the cairngorm, sometimes in such quantity as to constitute almost half of the whole. The cairngorm was detached from the rock when found as such occurrences so frequently are; there was no tinstone associated with them.

An auriferous tourmaline was prospected at Mundoe (Ashford-Bonshaw) assaying 33 dwt. gold. It was seen in several occurrences with siliceous rocks of igneous origin.

Crystals were found on the Barrier Ranges entirely enclosed in white milky quartz. Each crystal was terminated, but was divided into several portions, each portion being removed some little distance from the nearest one and surrounded entirely by the quartz. There were four or five fractures in a length of 2 inches. The exact locality in which these were found cannot be recalled after many years, but it was probably north of Silverton.

Digitized by Google

Tremolite [$(Ca\ Mg)SiO_3$.]

A quantity of galena was brought into Silverton thirty-five years ago from somewhere in that district which contained a large percentage of this mineral. Apparently the deposit was of little importance as further supplies could not be obtained. Assays showed low silver values which were unpayable at the time. The galena was in masses with the tremolite in fibrous blades evenly disseminated through it. All the available material was sent to America, where it was regarded as a very interesting association.

Some of the largest "grass-stones" found at Tingha contained long fibrous inclusions resembling asbestos which were probably tremolite. One large specimen with wide blade-like inclusions in clear transparent quartz had been polished and was regarded as the finest "grass-stone" found in the district. The Writer saw only two specimens of this particular type.

Wollastonite ($CaSiO_3$).

Wollastonite was seen in the East Cornols mine (Broken Hill) in white fibrous masses and was analysed with the following results:—

SiO_2	50·20
CaO	45·50
Al_2O_3	1·09
Fe_2O_3	1·65
MgO	1·55
H_2O	·28
	100·27

Specific gravity, 2·94.

A more recent discovery in the South Blocks mine, also at Broken Hill, consisted of pale brownish-red tabular crystals in cubical galena. This has been described by T. H. Smith.*

Zircon.

Hyacinth (ZrO_2SiO_2).—This variety is found in many parts of the State in surface drifts and deep leads. An almost constant associate of the sapphire, it appears to have resisted the forces of destruction to a greater extent. Dana† points out that it is one of the least alterable of minerals, as it contains no protoxides.

Large water-worn stones are obtained in the Oban and Armidale districts which may be cut into beautiful gems. Smaller stones occur on the Glen Innes-Inverell road, at Tingha, Sapphire, Bald Knob, Uralla, in the Macquarie River, and other localities. They are of frequent occurrence with alluvial tinstone, and at Uralla and in the Macquarie River with gold.

Very bright but small octahedral crystals may be found near the township of Uralla upon the surface. There are also larger less perfect somewhat water-worn crystals in the Rocky River in the same district, but these are of a different type. The finest crystals were seen at Tingha, but they were uncommon. With small grains of gold they were met with in water-worn fragments at Yarras.

Many of the larger stones are suitable for cutting as gems, as they receive a good polish, are transparent and flawless. With their characteristic lustre and rich colours they form beautiful objects, and it seems surprising they are not more used for ornamental purposes.

* Rec. Aust. Mus., 1923, Vol. XIV., No. 2, p. 107. † A System of Mineralogy, 1892, p. 275.

Digitized by Google

They vary in colour from red to light reddish-brown, the deep red predominating. Their associates are the same as those of sapphire, and they have been found similarly attached to fragments of basalt at Sapphire (Inverell).

Jargoon.—The colourless to yellow zircon is generally, though not always, found with the red variety, but it is less common. The best stones were seen at Uralla, Elsmore and Sapphire. They may be readily recognised, especially in the wet drift, by their superior lustre.

Occasionally an odd stone exhibits an exceptionally bright polish among a large number of normal type. This characteristic is noticeable in the diamond of Copeton, especially among the yellow stones, but was not seen in the sapphire or topaz.

Zoisite [$H_2Ca_4(R)_3Si_6O_{26}(R=Al_2Fe_2)$].

This mineral was found at Upper Bingara enclosed in quartz in aggregations of crystals of prismatic habit of a very light brown colour. It has also been recorded by D. A. Porter * as having been met with in this locality in slender prisms massed together transversely to the direction of the vein containing them. The colour was pale sulphur-yellow. Possibly the same occurrence is referred to.

(g) PHOSPHATES, ARSENATES AND ANTIMONATES.

Apatite ($3\,CaP_2O_8+CaCl_2$).

Apatite occurs in galena with spessartite and rhodonite in the Broken Hill lode in transparent light green grains. Small hexagonal prisms are also seen, but they appear to be uncommon. The presence of this mineral as small gray imperfect crystals in galena was recorded by Professor Liversidge, M.A.,† in 1895. According to Sir Douglas Mawson, D.Sc. B.E.,‡ large crystals have been met with in this lode.

Bindheimite ($Pb_3Sb_2O_8 + 4H_2O$).

This mineral was often seen in the mines of the Barrier Ranges, where it was known from its colour as "canary ore." It was asociated with other lead ores, and in the Consols mine with silver ores also. It had probably been derived from the alteration of antimonial galena, though in some deposits all traces of the original mineral had disappeared. In the Day Dream mine it occurred with cerussite, and in the Hen and Chickens mine adjoining, with azurite. In the Lily mine (near Thackaringa) it was mixed with cerussite and was sometimes seen in boulder-like masses of earthy material surrounded by a hard crust of calamine. Blocks of ore were found partly altered showing galena on one side and bindheimite on the other, but where the two minerals were together the latter was nearly always in nests or patches in the galena. It was never found in large quantity. The largest deposits were in the Hen and Chickens and Lily mines, where it formed odd bunches with other ores. It occurred in galena in the Consols mine, and when present in the silver-chloride stopes was richly impregnated with this mineral. Ordinarily in association with galena it assayed about 60 oz. of silver, but in the Day Dream and Lily occurrences its value varied from that amount to 300 oz. or over. In the Hen and Chickens mine, in which large and comparatively pure blocks of the ore were seen, the assay

* Jour. Roy. Soc. N.S.W., 1894, p. 23. † Jour. Roy. Soc. N.S.W., 1895, p. xlvi.
‡ Jour. Roy. Soc., S.A., 1912; Vol. II, Pt. IV, p. 394.

Digitized by Google

was 770 oz., while that containing much azurite had a bulk value of over 1,500 oz. The Consols variety ranged in assay value to several thousands of ounces, according to the degree of impregnation which was often plainly visible. The enriching mineral consisted of chloride or chloro-bromide of silver in all the mines. An impure variety was found at Meglo (Tuena). It was not seen in the Broken Hill lode.

Essentially a shallow level mineral, it did not extend very far downwards, never below the oxidised zone. Its colour varied from light yellow to orange: it was nearly always in earthy form though hard and compact small masses were seen.

Several samples from different mines were analysed, either wholly or partly, but the only analysis available is the following:—

PbO	43·09
Sb_2O_3	47·05
$CaCO_3$	5·00
Ag	·20
H_2O	5·90
	101·24

Chencvixite [$(Fe_2Cu_3)\ As_2O_{11} + 3\ H_2O$).].

This mineral was found in the Consols mine (Broken Hill) in yellow-green to green amorphous bunches. It was enclosed in limonite and only met with at shallow levels. Was also seen in various parts of the Ardlethan tin field of similar type. This was analysed by J. C. H. Mingayie and found to contain the following:—

As_2O_5	35·52
CuO	19·15
Fe_2O_3	22·27
Bi_2S_3	·06
Al_2O_3	2·11
CaO	·98
MgO	·06
P_2O_5	trace
SiO_2 (sol.)	·30
H_2O	12·32
Gangue	7·64
	100·41

Erythrite ($Co_3As_2O_8 + 8\ H_2O$).

Erythrite occurred at Carcoar as an encrustation upon glaucodot from which it had been derived through oxidation, and in which it was present as minute tufts of acicular crystals.

It was seen in the Consols mine (Broken Hill) in small stellate crystal groups upon limonite, and also as an encrustation upon cobaltite from which it had been changed.

At the Bismuth mine (Torrington) it formed an efflorescence upon smaltite as the result of surface weathering.

Mimetite ($3\ Pb_3As_2O_8 + Pb\ Cl_2$).

There were several varieties of this mineral which was only met with in the Broken Hill lode. It occurred in vughy or open ground generally upon limonite, garnet sandstone, or other lode material. The earlier discoveries, which were contemporaneous with the vanadate, were seen in several mines, the best examples being obtained from the Proprietary and Block 10. It

Digitized by Google

was always crystallised in hexagonal prisms, almost invariably with flat terminations. Some of the crystals were coated with a thin film of rich bronze-yellow or bronze-red substance, whose composition is unknown. The colours of these early crystals varied from colourless to white with shades of yellow and at a later date to bright yellow. All the crystals were found in groups which in some cases had been subjected to chemical action which had dissolved and removed the crystals in certain areas, leaving their skeletons or blank spaces showing where they had been. The latest form found was in large prisms of dull yellow to light brown colours which were almost as distinct in appearance from the earlier or shallower occurrences as the pyromorphite crystals were from each other. They probably differed in composition, and it seems likely there were several types. The white variety was found to contain CaO, and should perhaps be classified as hedyphane, but the composition generally was variable.

Campylite.—This interesting variety was exceedingly rare, but it was seen in very perfect barrel-shaped hexagonal crystals, the most perfect of all the lead arsenates, of a deep red-brown colour. The crystals were separate from each other and had been deposited upon the lode material in vughs.

Monazite ($5\ R_3P_2O_8 + Th_2P_2O_9$, where R = Ce La Di).

Monazite is found accompanying wolfram in irregular patches, with or without quartz, enclosed in granite or greisen, in pipes or joints along which the rock is often, but not always, decomposed.

At Tungsten a small deposit of bismuth oxide was followed in or near a joint in the greisen on either side of which was quartz about 3 inches thick, outside of this was a similar width of felspar, the whole being enclosed in greisen. These different bands merged into each other, the only division being the joint in the middle. The monazite was in the quartz near the joint and it was sometimes accompanied by crystals of beryl and oxide of bismuth. With this particular deposit there were occasional clay pockets in the greisen near the joint, which also might be found to contain these minerals.

The largest bunches of monazite were found at Cow Flat (Torrington), in which it was associated with quartz more or less crystallised. The most solid variety formed an isolated deposit in the rich wolfram occurrence in Donoghue's mine at Dingo Creek (Torrington), which is referred to under ferberite. It did not occur in any of these localities in sufficient quantity to be of commercial importance even if the thoria content had been satisfactory. The larger bunches were generally wholly amorphous, but crystals were met with occasionally. A few prismatic crystals from Cow Flat showed basal cleavage and pyramidal terminations. Compound crystals were found in Rumsby's mine (The Gulf) with large deposits of wolfram, which are also referred to under ferbrite. In this locality it was seen in joints in granite, which were being followed for the small bunches of wolfram they contained. The colour varied from yellow-brown to dark brown.

The largest quantity met with was at Elsmore, where some tons in the form of sand were collected during sluicing operations for the recovery of tinstone which in loose crystals was scattered over the surface. It was not seen *in situ* in this form and was not sought for, as it was of no economic value.

Digitized by Google

A sample from 11 miles north-west of Deepwater, which is not far from Torrington, was tested by J. C. H. Mingaye and found to contain:—

Ce_2O_3	70·71
La_2O_3	
Di_2O_3	
ThO_2	·77

Pyromorphite ($3\,PbO_3P_2O_5+PbCl_2$).

There were several varieties of this beautiful mineral in the Broken Hil lode. They might be grouped according to colour and difference in form which probably denoted variations in composition due to the relative depths at which the different kinds were found.

The following were distinct types:—

1. Canary coloured, very perfect, hexagonal prisms with smooth surfaces and hollow terminations. The first variety of this mineral seen in Broken Hill. It occurred in vughs in the oxidised siliceous lead ore of Block 14, but there was only one occurrence of it in this district known to the Writer.

2. Greenish-yellow crystals with hollow terminations and rough ragged appearance owing to divergence of the prisms. Found principally in the Proprietary mine.

3. Groups of short greenish-yellow smooth-surfaced doubly terminated prisms. Found in limited quantity.

4. Groups of small acicular light gray-brown prisms, sometimes transparent and almost colourless. Found in large quantity in the Junction mine in 1889, and the first pyromorphite seen in contact with the sulphide ore. It was deposited upon a siliceous skeleton of quartz and garnet sandstone from which the sulphides had been almost completely leached.

5. Very fine groups of smoke-gray crystals with rounded terminations due to the amalgamation of diverging hexagonal prisms. Found in the North mine soon after No. 4, and on the same kind of matrix.

6. Larger and more solid prisms of a pink-gray-brown variety were found near the sulphide ore in great quantity, in Block 14 particularly, but they occurred in other mines. These were the finest and most imposing of all the varieties because they formed such splendid large groups of crystals. Being a very brittle mineral little of it appears to have been preserved; the Writer has never seen a really good undamaged group in any collection comparable with what was so readily obtainable in large quantity *in situ*. For purity, perfection of form and general beauty the Block 14 deposit was not excelled by any of the wonderful mineral occurrences of this lode.

7. Very short, stout, doubly terminated prisms of the pink-brown type which are of more recent date. Examples may be seen in the Mining Museum which measure 18 mm. by 15 mm. and 24 mm. long.

8. Large mammillated and botryoidal masses formed directly upon the sulphide ore of gray to brown colour.

9. An amorphous variety, light gray or buff in colour, which constituted part of the outcrop. It was the only uncrystallised form of this mineral found in the lode and it occurred in great masses with manganic-ironstone.

Digitized by Google

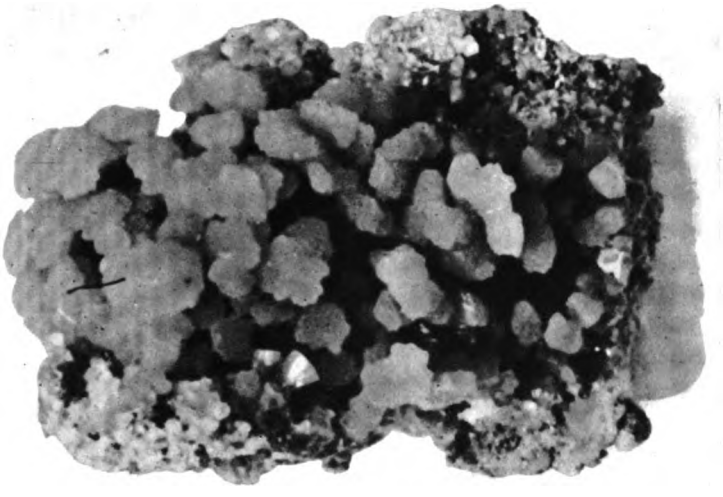


Fig. 1.—Pyromorphite crystals, North Mine, Broken Hill.

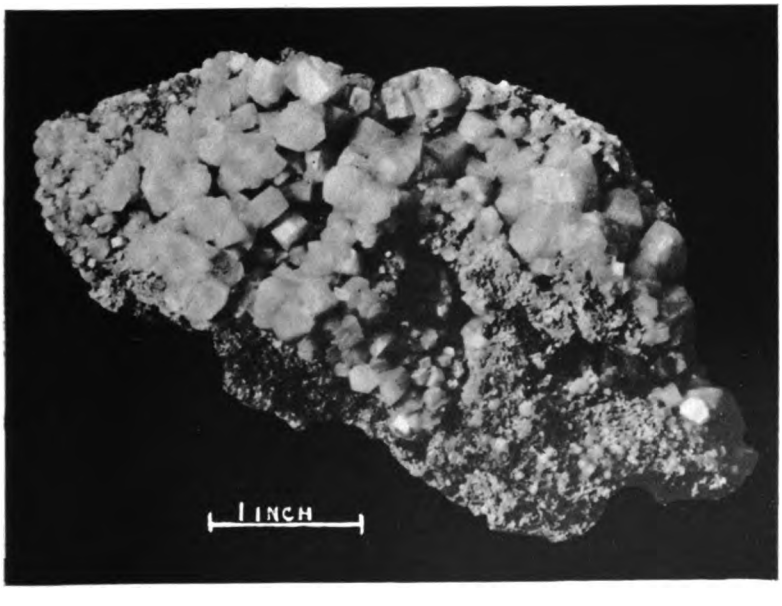


Fig. 2.—Pyromorphite crystals, Mount Stewart Mine, Leadville.

Digitized by Google

Digitized by Google

The greenish-yellow variety was analysed by J. C. H. Mingaye, who found it to contain—

PbO	80·80
CaO	·38
FeO	trace
Al_2O_3	·28
P_2O_5	15·58
Cl	2·65
	99·69

As, F, and MgO were proved to be absent.
Specific gravity, 6·895.

All the above varieties were of very pure types, and no doubt embraced several important gradations of composition. It is regrettable that each kind was not analysed when supplies were available.

Some very fine groups of green-yellow hexagonal prisms were enclosed in ferriginous material at Mount Stewart mine (Leadville). These crystals were 7 or 8 mm. across and rather less in length, so that they formed very short prisms. They had double flat terminations and were very perfect. Though they did not occur in such profusion, they were equal in several respects to the Broken Hill occurrences.

Very attractive, perfect, but smaller, light to dark green and gray-green hexagonal prisms, some doubly terminated, at Kangiara (Yass) were associated with clusters of cerussite crystals. Similar, but less fine, groups, together with a massive variety were among the surface ores of the East Consols mine (Broken Hill), the only green pyromorphite seen in that locality.

Well crystallized groups of a brownish-white variety were also found in the Carpathia mine (Ardlethan).

Scorodite ($Fe_2As_2O_8 + 4H_2O$).

Scorodite may be seen in the upper portion of several of the newly opened deposits of mispickel in the Pyes Creek (Tenterfield) district, forming yellow-green druses around and between bunches of that mineral from which it has been derived.

Also as encrustations in the granite adjacent to the deposits of mispickel in several localities. In the outcrop of the Ottery lode (Emmaville) it may be seen in greenish-white pulverulent patches due to the oxidation of that mineral.

Turquoise ($2\ Al_2P_2O_{11} + 5H_2O$ with CuO in varying quantity).

Turquoise was found near Bodalla, forming small veins up to half an inch in thickness enclosed in gray or black slate. Its colour was bluish-green to green, and so it did not exhibit the finer characteristic blue of the foreign and more valuable varities.

(4) TUNGSTATES, MOLYDATES AND VANADATES.

Cuprotungstite ($CuWO_4 2H_2O$).

Cuprotungstite is a yellow-green mineral found in limited quantity at Reids Flat (Burrowa) and in the Cordillera (Tuena) and Tungsten Limited (Frogmore) mines. In each instance it was intimately mixed with scheelite which, especially in the case of the Frogmore ore, it appeared to have partly

Digitized by Google

replaced. It occurs as nests in the scheelite and apparently is impregnated through it. In similar form it was found with copper ores at Yeoval. It is of waxy appearance, sometimes earthy and shows no trace of crystallization.

This mineral was formerly regarded as a tungstate of copper and lime ($CuWO_4 + 2\ CaWO_4$) and was then called cuproscheelite. At a later date an analagous substance containing less lime was recorded under the name of cuprotungstite ($CuWO_4$). According to Frank L. Hess* these minerals are identical, as has been shown by further investigation, and they are apparently due to the alteration of scheelite. Cuproscheelite is therefore regarded as a mixture of cuprotungstite and scheelite, which are two definite minerals.

Ferberite ($FeWO_4$ with a little MnO).

This mineral occurred in large quantity from small specks to large solid masses. These rarely showed crystallization, unless there were cavities in which crystals were sometimes found, with or without clay. Occasionally a large slug would be seen with coarse crystals forming part of it. The larger blocks cleaved very readily into lustrous slabs of brownish-black colour. Cleavages, without any flaw, were as large as 7 by 4 inches, but there were larger slabs with cracks or other flaws.

Some of the largest masses of clean ore were found in Rumsby's mine at The Gulf. It was of normal type without crystallization, but was more than usually interesting because of its mineral associates. Like some other deposits of ferberite upon this field it was accompanied by large bunches of clear bright green fluorite, and beryl and monazite in small quantity. With the fluorite were a number of fine quartz crystals of drusy type which had lined vughy parts of the pipe, but all were detached, as were the other minerals, from the rock to which they had originally been attached. They were thus loose in the pipe in similar manner to some of the beryls and other minerals at Torrington. The similarity was increased by the fact that the quartz crystals were much corroded at the base, and for some distance towards the apex they were deeply pitted. The accompanying minerals had not been affected in this way to any appreciable extent, if at all. As at Torrington the solvent had had a selective action, its destructive effects were not general. In depth the ferberite almost wholly pinched out, various copper minerals taking its place. Similar masses of ferberite were obtained in Donoghue's mine at Dingo Creek (Torrington), the only associated mineral being monazite, which was present in the largest solid pieces seen in the district, but there was apparently but one bunch of it.

Small deposits were met with in the Butler mine (Torrington), consisting of thin crystalline plates interleaved with quartz and associated with cassiterite and a small amount of galena. The same association, also in the platy form, was seen at Elsmore. Of the massive type it was enclosed in quartz with cassiterite at Wilson's Downfall and Mount Tallabong (Condobolin), the same association in different form being found at The Gulf.

At Glen Eden (Glen Innes) it was followed downwards for 100 feet or more in a very large quartz pipe, in which molybdenite was also present, each mineral being in isolated patches scattered irregularly through the quartz. A similar but smaller and richer occurrence was prospected at Wunglebong (Tenterfield) in which, as it was opened near the surface, each mineral gave promise of favourable developments, deeper exploration, however, did not fulfil this early promise.

* Tungsten Minerals and Deposits, Bulletin 652, 1917, pp. 32-33, Dept. of Interior, U.S., America

Digitized by Google

To face page 84.

PLATE XXIII.

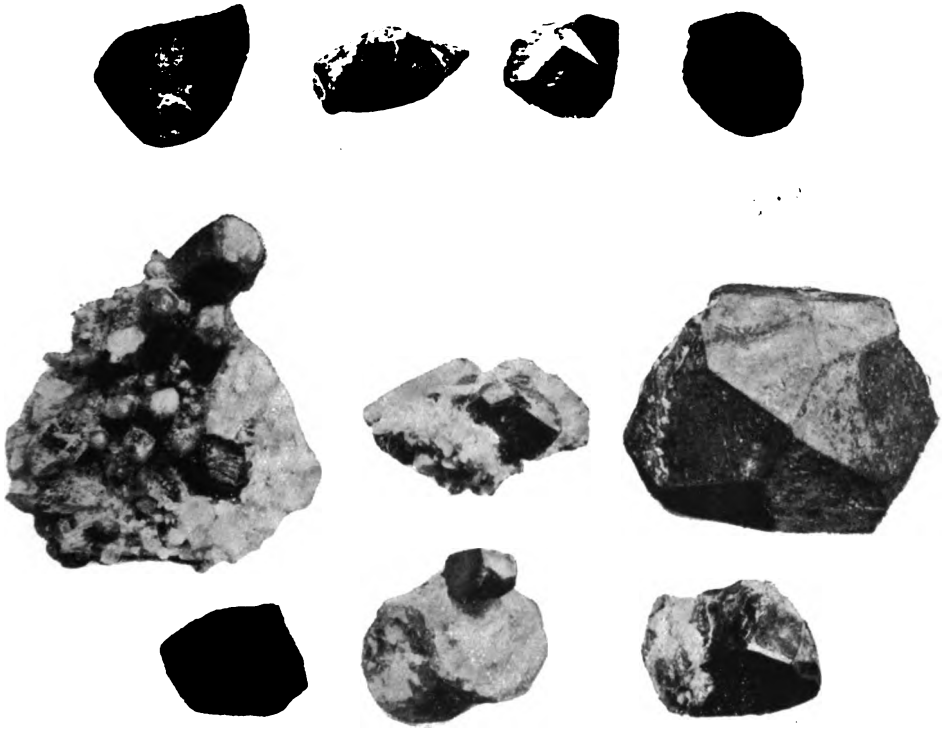


Fig. 1—Crystals of Ferberite, Torrington.
Bottom group showing crystal surrounded by Quartz and Topaz Crystals.

Digitized by Google

Digitized by Google

At Broken Hill it was found in a seam at the 400 feet level of Block 14 mine, together with scheelite. A parcel formed of "slugs" was obtained at Waukaroo (Barrier Ranges) thirty-two years ago, which was sent to Germany. The occurrence was patchy, the ore being in isolated lumps in a very soft micaceous greisen. The following analysis was made of a sample representing the average value of the shipment:—

MnO	6·78
FeO	19·01
WO_3	64·28
Insoluble, etc.	10·00
	100·07

At Cow Flat (Torrington) ferberite was seen undergoing replacement by quartz, which had first followed the cleavage planes in very narrow seams and gradually widened until the ore was replaced. On one side the unaltered ferberite could be seen exhibiting an early stage of penetration; on the other replacement had been completed, pseudomorphism being well illustrated.

In the Block 14 mine (Torrington) a large boulder of pure ferberite, associated with light green fluorspar was found to be penetrated by thin veins of native bismuth. Large lumps of ferberite have recently been seen in a molybdenite pipe at Kingsgate, sometimes enclosing fragments of that mineral. Portions had been changed to tungstic oxide, a very rare mineral in the Northern district. The more solid and unaltered parts were covered with a very rich blue-purple tarnish. This iridescence was observed also upon some of the ferberite at Torrington, the brilliant colours resembling what is seen upon some varieties of limonite.

About 2½ miles west of The Gulf perfectly developed quartz crystals were found enclosing ferberite. The best example seen by the Writer was 2 or 3 inches in diameter and possibly 3 inches long. The ferberite filled the inside of the crystal leaving a quarter inch band of quartz which formed the outside of the crystal. It was interesting to speculate upon the order in which the minerals were deposited, whether the quartz was formed upon and around the ferberite, which could be seen at the base passing upwards into the crystal in a rather decomposed condition, or whether it was being replaced. In view of the even thickness of the surrounding quartz and its unaltered condition it seemed most probable that it was the more recent deposit. Had there been replacement less regularity would probably have been shown along the line of contact.

Good single crystals were met with in vughs in the greisen, sometimes accompanied by crystals of smoky or white quartz, and, very rarely, also topaz crystals; but owing to their ready cleavage they were fragile, and many crystals were broken in detaching them from the containing rock. Some were, however, naturally detached in clay pockets. Groups of crystals were rarely seen, double terminations were also rare, but they were found in the Wild Kate mine, which twenty years ago yielded a large number of perfect crystals. At Tungsten (Torrington), a small mine in greisen operated on a small scale, in a short period yielded many desirable crystals, some large, 4 inches by 2½ inches, and all with good terminations. Nearly all of the crystals were of prismatic habit, but it was seldom they were without some slight damage.

Other localities were Cow Flat and Cobalt (Torrington), but the crystals seemed to be confined to certain areas, and to a great extent to certain mines

Digitized by Google

A radius of 3 miles from the largest mine at Tungsten, the Rockvale, would embrace practically all the Torrington localities. Although this mine was one of the two largest producers on the field, probably in the State, whose output exceeded that of all the small crystal mines combined, it did not, so far as the Writer is aware, produce any crystals, though its ore was probably unsurpassed for purity.

Groups of small tabular crystals were seen at The Gulf, where in some deposits they were coated with limonite.

Hübnerite ($MnWO_4$).

Hübnerite, a rare mineral in this State, was met with in small bunches at Torrington. It occurred in red-brown crystalline masses with quartz, and in black blade-like crystals forming radiating groups in chlorite, any openings remaining in the mass being lined with quartz crystals. It was not found in sufficient quantity to be of economic value.

Molybdite (Fe_2O_3, 3 Mo_2, 7½H_2O).

This mineral was formerly regarded as molybdenum tri-oxide, but recent investigation shows it to be a hydrated iron molybdate. It has been described and analysed by T. H. Smith*, who found it to be composed of the following:—

H_2O	18·40
Fe_2O_3	22·81
MoO_3	56·81
Insoluble	1·67
	99·69

It occurs in crystals and in encrusting and pulverulent forms of a uniform canary-yellow colour, distinguishable from bismite with which it often occurs, by its lighter hue.

As a result of the alteration of molybdenite it is always found in the vicinity of that mineral, most commonly as an encrustation in cracks, joints, or crevices in quartz. At Wunglebong (Tenterfield) it was seen in the cleavage planes of felspar, in the Whipstick mines (Jingera) in garnet rock, and in granite with the oxidised ores of bismuth, in each case in its earthy form. It was sometimes seen occupying spaces from which molybdenite had been leached.

The largest and finest deposit of the encrusting variety was seen on the surface of Weir's mine (Wunglebong). A large area was impregnated, the molybdenite from which it had been derived having been completely altered or removed. In its pulverulent form it was best seen at Whipstick, but good samples were found in quartz-molybdenite pipes at Bald Knob and Kingsgate, though little has been seen in the latter locality during recent years as the workings of the more important pipes are well below the zone of oxidation.

It was rather uncommon in definite crystals, but some very fine bunches of acicular prisms were found in vughs in quartz at Glen Eden (Glen Innes). The crystals were very slender and fragile, some half an inch or more long, and probably the best found in the Northern district. Many good examples of the encrusting variety were also seen in this deposit, which was not of high grade in its molybdenite values.

* Rec. Aus., Mus., 1923, Vol. XIV, No 2, pp. 105-106.

Digitized by Google

Almost equally fine crystals, though smaller, were met with as delicate radiating tufts in a quartz vein at Wilson's Downfall, together with a small quantity of molybdenite. It is from this occurrence that the material was obtained for Mr. Smith for his analysis.

The quantity of oxide formed does not necessarily bear any relation to the molybdenite value of the deposit. The Writer knew from their inception the rich pipes of the Allies and Cooper's mines (Deepwater), but he saw it in neither of them. Molybdenite does not oxidise uniformly. In some districts it may outcrop without alteration, in others it may have been removed for some distance downwards leaving nothing but the empty casts of the crystals free from any mineral, while in others it might show the sulphide in all stages of alteration to the clean oxide. Molybdenite contained in tailings carried into the creek at Kingsgate, when bismuth was the only objective, remained unaltered after exposure for over twenty years, while similar ore at Bow Creek (Deepwater) oxidised on the surface in a few months.

Raspite ($PbWO_4$).

Raspite is a new form of lead tungstate found in the Proprietary mine. It occurred in small tabular yellow-brown lustrous prisms upon manganiferous lode material, with, or without, stolzite as an associate. One of the rarest of the minerals found in the Broken Hill lode, though, being a very unimposing object, it may have existed in larger quantity than is indicated by the very few specimens that were obtained. It has been described by Dr. C. Hlawatsch of Vienna*, who also supplies the following analysis by Professor Treadwell, of Zurich, who had but 0·1331 gr. for this quantative determination :—

WO_3	49·06
PbO	48·32
$Fe_2O_3 + MnO$	1·43
	98·81

Scheelite ($CaWO_4$).

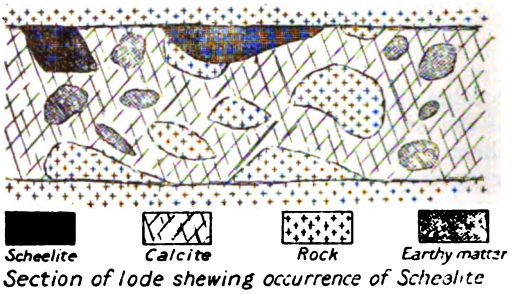
Considerable quantities of this mineral were found in the many veins of Hillgrove, often accompanied by antimonite and calcite. Solid irregular bodies of white to fawn or light brown colour were not uncommon, but, as a rule, it was distributed here and there through the veins in patches and was very erratic in its occurrence. The mineral showed little variation, it was crystalline, but seldom in definite forms, and these also were generally incomplete. The best crystals were of pyramidal habit, single or compound, rarely in groups of pyramidal forms showing parallel growth.

One of the richest of the lodes was developed in the Damifino mine, in which the ore was usually in detached bodies with patches of rock (granite), calcite, or antimonite through it. In exceptionally rich parts, where the lode had narrowed, the scheelite for short distances horizontally and vertically occupied the whole of the fissure and then formed a vein of solid ore up to 12 inches thick. Where it was unmixed with calcite or antimonite, the ore was clean and pure, as it was throughout the district, but there were no crystals in this mine though there were many interesting enclosures of these minerals within the scheelite.

* Rec. Geol. Survey; N.S.W., 1898, Vol. VI, Pt. 1, pp. 51-61.

Digitized by Google

The following sketch shows the vein pinched to 6 inches and comparatively poor. As will be seen it contained no antimonite at that point.



Section of lode shewing occurrence of Scheelite
Damifino Mine, Hillgrove
(3.9.19)

Fig. 1.

An impregnated much altered rock, near the town of Hillgrove, contained a number of small parallel veinlets varying in thickness from very thin streaks to veins nearly half an inch wide. Thirty were counted in a width of 6 inches, all were pure white, and they formed a distinct type of occurrence which was locally known as "ribbon scheelite."

A translucent greenish-yellow variety at Moonbi was unusually pure and well crystallised. It was found as small bunches in short vein like deposits up to 6 inches in width, which might have improved on further development, but like other deposits of its class it was too patchy to offer much inducement for continued prospecting. It was enclosed with a little molybdenite in a porphyritic rock surrounded by granite, which being somewhat cavernous contained some well developed crystals of scheelite with equally good orthoclase crystals. Its bulk value was 77 per cent. WO_3.

Scheelite was found at The Gulf in small quantity, which included crystals of the usual pyramidal habit and drusy type, made up of tiny crystals of similar form. Upon parts of the crystals were patches of a brown pseudomorphic mineral which appeared to be wolfram in the process of replacement of the scheelite.

It occurred in Block 14 (Broken Hill) at the 400 feet level with wolfram, and also in the Cordillera (Tuena) and other mines with cuprotungstite. Water-worn fragments have been found at Skeleton Creek (Glen Innes) in the tin concentrates obtained in sluicing operations on the surface, but this and similar occurrences elsewhere were too small to be of any economic importance.

Stolzite ($PbWO_4$).

This beautiful mineral, although belonging to the upper portion of the oxidised zone was a comparatively late discovery. It was seen by the writer in the early part of 1894 in single yellow tabular crystals on a ferrugenous base, but later, as the open cut workings were extended, other varieties were found in quick succession. Like most of the other rare minerals it apparently belonged to one portion of the lode. The following varieties were found. they were generally seated upon manganic-ironstone and quartz or garnet sandstone. All were from the Proprietary mine (Broken Hill).

1. Rather small straw-yellow tetragonal tables.
2. Short thick smoke-gray prisms with very flat pyramidal terminations or double pyramids without prism.

Digitized by Google

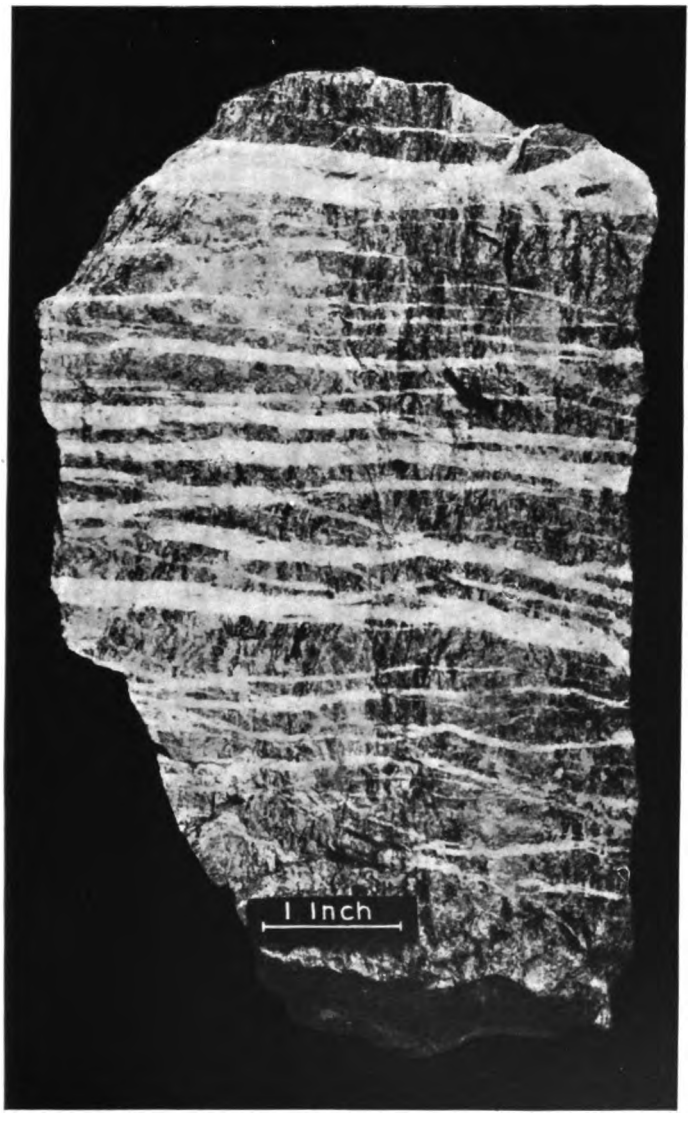


Fig. 1.—"Ribbon" Scheelite, Hilgrove.

Digitized by Google

Fig. 1.—Smoke-grey variety.

Fig. 2.—Red-brown variety.

STOLZITE CRYSTALS, PROPRIETARY MINE, BROKEN HILL.

Digitized by Google

Anglesite ($PbSO_4$).

This, one of the finest examples of the Broken Hill crystallisations, in its occurrence resembled pyromorphite. In purity and form both were perfect, in depth their crystals were larger and improved both in quality and quantity. Each continued to the sulphide zone, and in actual contact with the sulphide ores their largest and most magnificent groups of crystals were found. As with both pyromorphite and cerussite—there was perfection in great profusion.

In the Central mine a very large deposit of beautifully crystallised cerussite was exposed, upon which numberless brilliant white crystals of anglesite were deposited. Much of the former was of the reticulated variety with long slender prismatic crystals, reaching across the cavities in which the best crystals are always found, and upon the delicate threads which formed a part of these crystallisations, tiny but perfect crystals of anglesite were seated. Many of the acicular prisms of cerussite, which were encrusted with little groups or single crystals, seemed too fragile to bear their burden, and, as if to assist when necessary in carrying the load, the anglesite crystals had each adhered to the next in position, and so formed solid aggregates corresponding with the form of the cerussite.

As a display of brilliance the occurrence just described was unique even in this lode, but finer crystals of anglesite were yet to be discovered. These were found in Block 14 mine as a flat mass lying directly upon the much altered sulphide ores without any mineral associate. There were numerous openings in this more solid variety of anglesite, in each of which were clusters of beautifully perfect translucent sherry coloured crystals. There were no individual crystals similar to those of the Central deposit, which were simply an investment upon a different base, but a mass of which the crystals were an integral portion. There was no uncrystallised part, it was made up of vughs and crystals and yet formed a compact whole.

Besides these were many other occurrences of this mineral. Very fine large yellow tinted crystals were found in the Proprietary mine, and the smaller colourless to white variety in all the mines. They occurred in vughs, and all were of the same high standard of excellence.

The amorphous variety which occurs as an alteration of galena *in situ* was not seen by the Writer in the Broken Hill lode, it probably did not exist there. It was not uncommon on the Barrier field and in many other localities, sometimes enclosing an unaltered core of galena and itself surrounded by the earthy form of cerussite. The best varieties in which the three minerals (sulphide, sulphate and carbonate of lead) could be distinctly seen were found in the Pioneer mine (Thackaringa), but the most interesting of the altered sulphides of this type were probably those from Potter's (Condobolin). These consisted of black to brown anglesite showing the progressive stages of its oxidation by well-marked concentric layers around the galena, which remained bright and unaltered in the centre. The markings were very distinct and were due perhaps to variations in the solutions which had affected the change. In these altered minerals pseudomorphs of anglesite after galena were sometimes seen.

Carbo-sulphate of Lead ($PbCO_3 + 4\ PbSO_4$).—A mineral differing from any known species was found in the Broken Hill lode. Only one example was seen, which consisted of a group of colourless well-formed crystals of prismatic habit seated upon a base of siliceous lode material. This mineral has been examined and analysed by T. H. Smith, who states that the

Digitized by Google

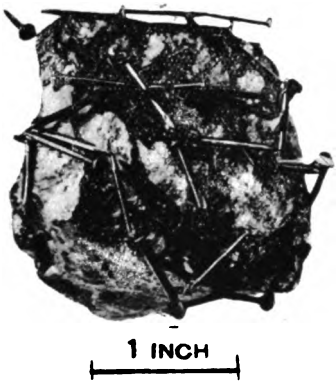


Fig. 1.—Magnetite, Lionsville.

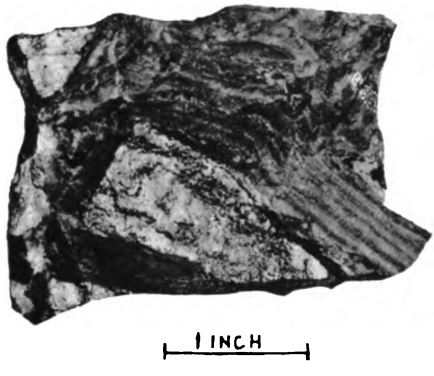


Fig. 2.—Galena (in centre) showing change to Anglesite. Potter's Mine, Condobolin.

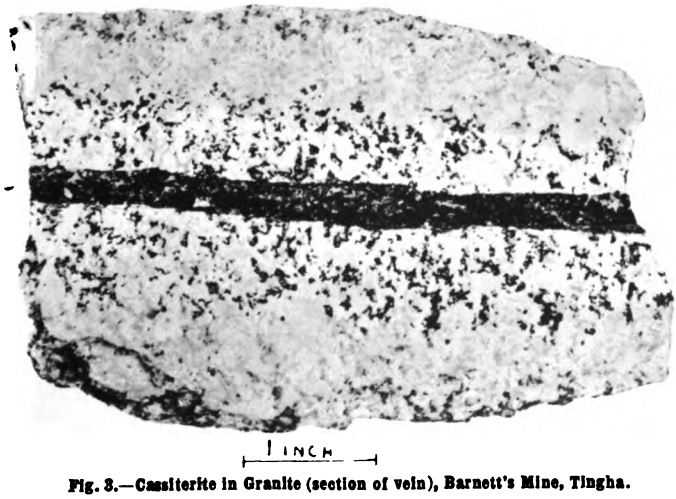


Fig. 3.—Cassiterite in Granite (section of vein), Barnett's Mine, Tingha.

Digitized by Google

Digitized by Google

crystal faces are too curved to permit of correct readings. All the optical properties determined agree with those of anglesite, and therefore it appears probable it is identical with that mineral partly replaced by cerussite. The analysis shows the composition to be as follows :—

$PbCO_3$	18·33
$PbSO_4$	80·70
	99·03

Barite ($BaSO_4$).

Pretty groups of stout tabular crystals of barite of various shades of colour, varying from yellow to brown, were met with at 130 feet in the Peak Hill mine (Peak Hill), lining vughs in a ferruginous portion of the auriferous rock of the mine. These crystals were found in some quantity and were perfect in form. Upon some of the larger crystals a later growth had encrusted them with small slender prisms of the same mineral. These little crystals were confined to the middle portion of the larger forms where they were bunched together, the outer parts and ends of the large crystals remaining uncovered.

In the adjacent Golden Crown mine the same mineral was found in different forms. At 175 feet very lustrous tabular crystals were seen, which were colourless and transparent, but appeared to be yellow, owing to the colour of the ferruginous material they were seated upon showing through them. At a lower level larger, moresolid, columnar, colourless, transparent to translucent crystal groups were enclosed in soft decomposed cupriferous pyrites, of which at this level the lode was composed, and which contained high gold values.

Large amorphous bodies of barite were met with in the Commonwealth mine (Wellington), in which it was associated with masses of pyrites containing blende and chalcopyrite. Occasionally groups of colourless crystals were present.

It was also found in the Atlas mine (Purnamoola) in small bunches of an amorphous vesicular variety. In the openings silver chloride could be seen; the assay value of the deposit was 180 oz. silver.

Barytocelestite (baryto-sulphate containing varying quantities of strontia sulphate). This variety has been found in nodules of a light gray colour in a gypsum deposit near Trangie. It was analysed by J. C. H. Mingaye and found to contain the following :—

$BaSO_4$	51·29
$SrSO_4$	40·96
SiO_2	5·37
CaO	·20
MgO	·05
Fe_2O_3	·65
H_2O and undetermined	1·48
	100·00

Brochantite ($Cu_4SO_7 + 3\ H_2O$).

Brochantite was met with in the Broken Hill and Consols lodes, but always in very limited quantity. As little bunches of acicular crystals of emerald green colour it was associated with linarite and native copper in a large cavern in the British mine. In similar form it was found with other secondary minerals in the Proprietary and other mines. As an encrustation also it was met with in the Broken Hill lode, and as crusts in vughy limonite it was associated with vanadinite in the Consols mine. It was confined to the shallow levels and, like several of its contemporaries, had a limited range in its occurrence.

Digitized by Google

Chalcanthite ($CuSO_4 + 5\ H_2O$).

Clusters of sky blue crystals of chalcanthite were numerous in the Mount Costigan mine (Tuena) as a result of the oxidation of copper sulphide within the rock upon which they had been deposited.

In the Gulf Creek mine (Barraba) it formed unusually fine single crystals and groups of dark blue colour, which were due to the action of surface waters upon the decomposing underlying sulphide ores.

Bunches of stalactites were seen in the adit level of the Conrad mine (Howell), where they were accompanied by similar stalactites of melanterite. They were very numerous in 1905, as were those in the Gulf Creek mine, but the Writer was unable to discover any in later years.

It is a common mineral in limited quantity in many of the copper mines throughout the State.

Halotrichite ($FeO\ SO_3 + Al_2O_3SO_3 + 22\ H_2O$).

Halotrichite is an iron-alum found in quantity in the Central Greta colliery (Maitland), being derived from the oxidation of pyrites in the shale roof of the coal seam. It occurs in fine silky capilliary fibrous white crystals, which have been analysed by J. C. H. Mingaye and found to contain the following:—

FeO	9·90
Fe_2O_3	trace
Al_2O_3	8·82
MnO	·10
MgO	·77
K_2O	·17
Na_2O	·45
P_2O_5	trace
SO_3	34·52
Insoluble	2·24
H_2O by dif.	43·03
	100·00

This mineral was also seen with the decomposing sulphide ores of the Gulf Creek mine (Barraba), where it formed bunches and crusts, which were covered with small white acicular crystals of the mineral.

Kalinite ($K_2Al_2S_4O_{16} + 24\ H_2O$).

Kalinite was met with in the alunite deposits of Bullah Delah in transparent colourless crystals of octahedral habit, but they were rather indistinct in their forms.

Linarite ($PbCuSO_4 + H_2O$).

This rare mineral was found in an immense vugh in the British mine in small clusters of pretty azure blue crystals. Though the vugh was so large, the crystals could be seen here and there over the whole of that portion of the roof that was visible. A whitish aluminous material had first coated the roof and it was upon this that the crystals were deposited. With them were smaller green acicular patches of brochantite, with many stalactitic growths of crystalline native copper. The latter was coated with the aluminous substance, and slightly changed to malachite, on some were tiny crystals of cerussite. The other minerals were unaltered and without this coating, so were probably of later deposition.

Digitized by Google

At the time of its discovery the linarite was believed to be azurite and therefore little of it was collected. A large number of small groups of crystals could have been obtained, though they were very fragile. When the identity of the mineral was known it was too late to obtain further supplies as the vugh had collapsed.

Similar transparent bright blue crystals from the Proprietary mine were of a rather larger type. They were well developed prisms with fine terminations forming small clusters upon a base of cuprite, malachite and cerussite also being present.

A distinct variety from the same mine consisted of chalky-blue patches upon cerussite. This appeared to be earthy, but a strong lens showed it to be composed of aggregates of minute acicular crystals.

Melanterite ($FeSO_4 + 7\ H_2O$).

A number of stalactites of melanterite of a light green colour were found, with smaller stalactites of chalcanthite, in the adit level of the Conrad mine (Howell), where they had been left by mineral waters which had passed through the decomposing ores overhead. It is not uncommonly seen in mines in which there are bodies of decomposing pyrites.

Montanite ($Bi_2TeO_6 + 2\ H_2O$).

Montanite occurred at Norongo (Captain's Flat) encrusting tetradymite, from which it had been derived. It formed a pale yellowish compact mineral, and in that locality was itself enclosed by a reddish brown earthy alteration product which was regarded as a ferruginous variety of montanite, pseudomorphous after pyrite. These minerals have been described by J. C. H. Mingaye*, who has also analysed the second variety referred to with the following results :—

Bi_2O_3	50·68
TeO_2	27·65
Fe_2O_3	14·38
H_2O	6·16
SiO_2	1·00
	99·87

Specific gravity ..... 3·789

Montanite was associated with other oxidised ores of bismuth which were found in sufficient quantity to be mined on a commercial scale at Nanima (Yass) twenty-one years ago. It contained flakes of the unaltered tetradymite, was yellowish in colour, and more or less earthy, but the quantity was very limited.

Selenite ($CaSO_4 + 2H_2O$).

Crystalline masses of a colourless transparent variety of selenite were found in the South Mine (Broken Hill). They occurred in a vugh associated with galena and blende.

(*j*) CARBONATES.

Aragonite ($CaCO_3$).

Aragonite was seen in amygdaloidal basalt associated with zeolites. It was present in clusters of white crystals with very fine groups of chabasite in the basalt in Reidy's shaft near Emmaville. In radiating patches of yellow-

* Aust. Assoc. Adv. Sc. 1888 (9) 1, pp 116–12?.

Digitized by Google

brown crystals, it was met with accompanying natrolite in basalt in the Elsmore-Newstead Junction shaft near Elsmore. It may still be seen on the surface forming bunches and veins of parallel red-brown prisms in basalt on the left bank of the McIntyre River at Inverell.

It occurs in several mines of the Broken Hill lode in white and green-tinted radiating masses, some of which are partly changed to calcite.

Azurite ($Cu_3C_2O_7 + H_2O$).

Crystallizations of azurite of great perfection were met with in several localities associated with malachite, but in more interesting forms than those of the latter, as azurite shows definite crystals. Though many fine and sometimes perfect crystals were seen in the mines of the Cobar district, they were eclipsed by those of Broken Hill. The latter were very lustrous, of prismatic habit with pyramidal terminations, rarely doubly terminated, or in short tabular forms. The radiating variety of the Cobar field was not seen at Broken Hill. The groups were sometimes magnificent and the crystals immense; for abnormal growth they were unusually perfect. Probably the finest group found at Broken Hill consisted of several smaller, though still large, prisms with a central crystal 2½ inches long by about an inch wide. All were terminated and, as the Writer remembers them, flawless. This beautiful group was obtained in the Proprietary mine and was taken abroad thirty years ago.

Equally perfect, but much smaller, tabular prisms were seated upon psilomelane forming separate groups, with occasional crystals of embolite or iodyrite in association. Other groups of crystals were deposited upon limonite or other lode material, and with each of these occurrences crystals of other minerals, most frequently cerussite, were associated. Such combinations were similar to those occurring with malachite and were equally beautiful and perfect.

Very fine examples of pseudomorphism of malachite after azurite were met with, frequently the change was partial only, one portion of the crystal, the apex generally, being affected. Of a group one or more crystals would perhaps show alteration in patches, the others being unchanged. The higher qualities of the Broken Hill azurite were reproduced in the pseudomorphs, and this placed them above those of Mount Hope, excellent in most respects though the latter were.

There were many handsome crystallizations found in the Cobar-Mount Hope district, consisting of radiating aggregates, rhombohedral forms, and short prisms. These, like most of the azurite of this district, were of lighter blue than those of Broken Hill, and, as representative of their particular type, they formed very attractive specimens. The most perfect seen by the Writer were found in the Cobar Gladstone mine, consisting of groups of tabular crystals, some large, which, being more crowded and less fine, were unequal to the Broken Hill occurrences, but in lustre and general condition they were unsurpassed, while their light-blue transparency was unequalled by any others. They have been described by Dr. C. Anderson, M.A.*

Similar crystals of good colour and form were found in groups enclosed in gossan and associated with cerussite at Mineral Hill (Condobolin). These also have been described by Dr. Anderson.† Smaller and less interesting types are found in many localities.

* Rec. Aus. Mus., 1922, Vol. XIII, No. 5, pp. 211-212. † Jour. Roy. Soc., N.S.W., 1917, li., pp. 275-287.

Digitized by Google

Digitized by Google

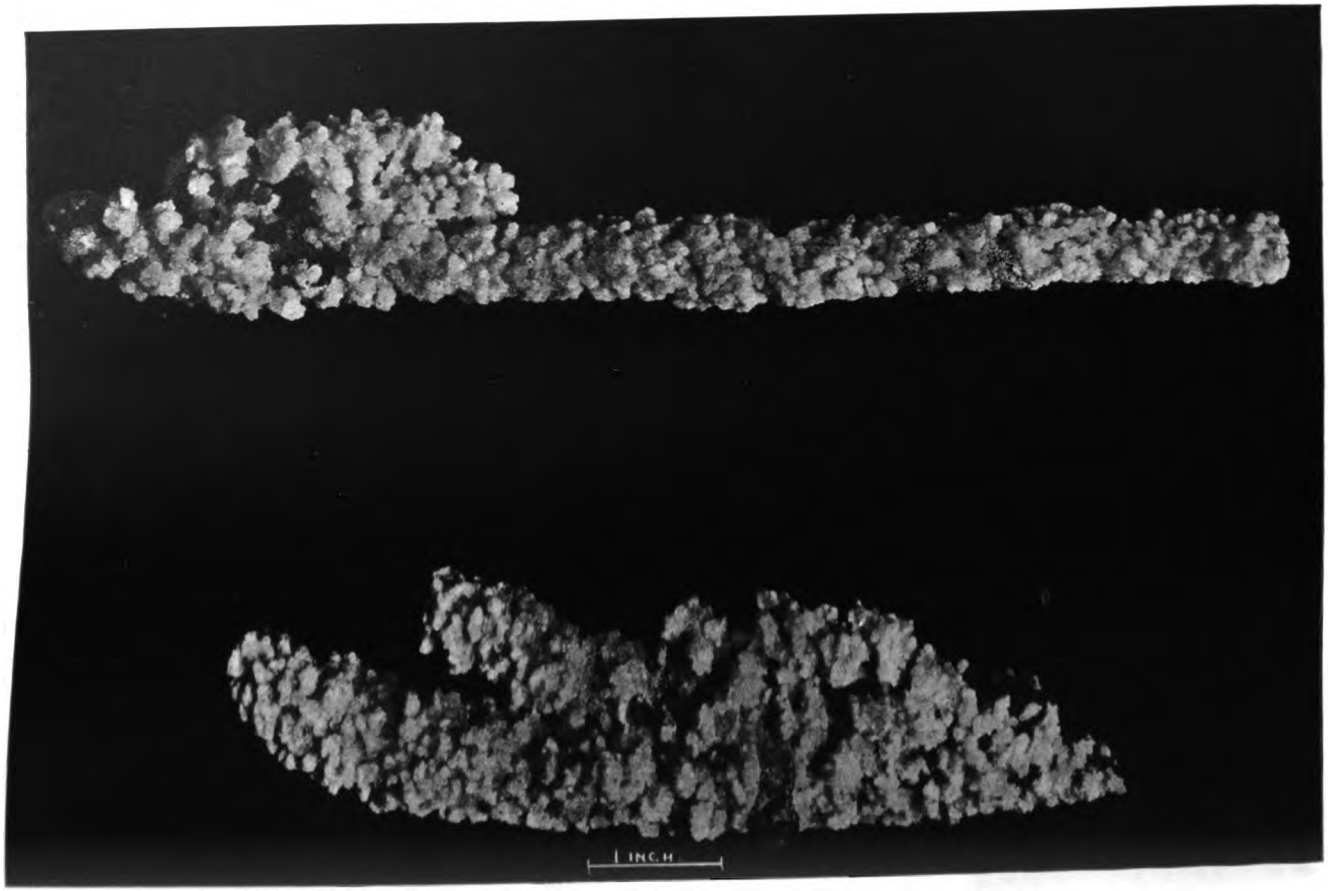


Fig. 1.— Calamine encrusting stalactitic Psilomelane, Proprietary Mine, Broken Hill

Digitized by Google

Of the amorphous varieties there were many occurrences. In the Cobar-Mount Hope district the azurite was veined with chalcocite and malachite, and streaked with white clay. In section they were very attractive, especially when cuprite was also present. At Gumble (Molong) a massive form was associated with cassiterite of which it contained a large percentage. At Furnamoota (Barrier Ranges) it composed a solid 6-inch lode, through which were small veins of silver chloride. It was a frequent associate of the silver ores of that field.

Bismutite ($2Bi_2C_2O_{12} + 9H_2O$).

Bismutite occurs in pulverulent form, often intimately mixed with the oxide (bismite). Fragments more or less rounded were found in the shallow alluvium of Elsmore and Skeleton Creek (Glen Innes) where it became concentrated with the tinstone, but the quantity was not appreciable. It was of common occurence as an encrustation upon other bismuth ores, particularly native bismuth, from which it had been changed. Bunches of a compact variety were enclosed in a quartz pipe with molybdenite near Deepwater, and unmixed with other ores, which was unusual.

It was not uncommon in the upper portions of the molybdenite pipes and in some of the shallow wolfram deposits in an earthy form with the oxide. Much of it had been derived through the oxidation of native bismuth, which could sometimes be found in the centre.

It may be seen in small patches in the quartz veins of Mount Barney (Newton Boyd) with other bismuth minerals.

With the oxide it was found in quantities of economic importance at Namina (Yass). The deposits also contained the rare tellurate (montanite).

Large "slugs" were found in the Tara mine (Broken Hill) over thirty years ago, one of the largest being thickly encrusted with silver chloride. Several smaller pieces were obtained in which this mineral was present, but it was not generally distributed through them. Assays showed 62 and 70 per cent. bismuth with 2 oz. 5 dwt. of silver per ton.

In colour it varied from white to yellow and fawn to light brown and gray. Several shades could be found together on the concentrating tables with wolfram, though it was generally present in small quantity.

Calamine ($ZnCO_3$).

Calamine occurred in groups of crystals upon stalactitic and mammillated psilomelane and, less frequently, limonite. These groups formed some of the choicest productions of the Broken Hill lode. It was always crystallized, the finest variety being perhaps the larger crystals which, either singly or in clusters, were seated upon psilomelane that had first been covered with a white encrustation of alumina silicate. From a fancied resemblance they were called "tear drops." These crystals were almost colourless and formed beautiful objects which were in keeping with their associates. Others of similar type and, perhaps equally attractive, were of delicate shades of green, due to the presence of copper salts. A smaller and colourless variety found in considerable quantity was deposited directly upon the psilomelane. This was the commonest form of the early discoveries, and was succeeded in even greater quantity by an opaque white kind which, as occurring in a large vugh, has been described elsewhere. These later crystals were, however, less well developed.

Digitized by Google

The crystals occurring most plentifully were comparatively small, but there were much larger types which appeared to be made up of aggregations of the smaller crystals, forming globular crystalline masses or groups of large crystals, but these were of uncommon occurrence.

The cupriferous varieties were not thoroughly investigated, but the amount of copper present was evidently variable and never sufficient to suggest that they were anything more than impure zinc carbonate. The largest groups were in very vughy ground, and in some cases the mineral upon which they had originally been deposited had been removed. They were all very attractive in their distinctive and well-crystallized masses.

The finest examples of each kind were probably found in the Proprietary mine, but the other mines yielded variations which possessed an interest of their own. Among the finest combinations were large prismatic crystals of cerussite which were encrusted with greenish crystals of calamine, but few of them were seen.

In the South mine there were pretty druses of small bright light green crystals surrounded by massive cerussite. In the Junction mine the lode material in vughy parts was encrusted and held together by a gray crystallized variety, which in turn was thickly encrusted with native silver.

Large stalactitic masses formed of aggregates of fawn-coloured rhombohedral crystals, were found in the Mount Stewart mine (Leadville). They were coated with a yellow to red-brown covering of limonite.

Calcite ($CaCO_3$).

A very interesting occurrence of this mineral may be seen in a large vugh in the Garibaldi Gold mine (Lionsville). It was intersected obliquely at one end by a tunnel which was being extended upon the auriferous vein of the mine. As exposed, its largest dimensions are 70 ft. by 16 ft. and 9 ft. high. It is lined with crystals of calcite of all sizes up to 2 feet or more in diameter, some are cloudy, but most are transparent of a slight sherry colour, or colourless, and fine examples may be obtained of the variety which shows double refraction clearly and is known as Iceland spar. Further exploration might show that the cavern extends beyond its known limits, but nothing has been done to enlarge it, and it remains as when first discovered. Though many of the crystals have been broken and removed, there yet remain so many intact that the damage is hardly noticeable.

Liquid inclusions from small to large bubbles as much as 2 inches long were seen containing possibly a dessertspoonful of the liquid. It is, however, rather difficult to obtain specimens which retain the liquid, as leakage occurs through the openings in which it exists if they connect with cleavages near where the crystals have been broken off the mass. The Writer in several attempts obtained nine or ten of these hydros, but in only two has the liquid remained. Some at least of the bubbles vary in shape from time to time, perhaps to-day showing several small ones which to-morrow are connected, to divide again later. If some hours could be devoted, with necessary tools, to a systematic search, it would be possible to secure many interesting specimens. The liquid is probably water, and though it leaks away so readily it does not appear to exist under any pressure. A very fine example of a bubble in the clear calcite, probably the best yet found in this deposit, may be seen in the Mining Museum, Sydney.

Digitized by Google

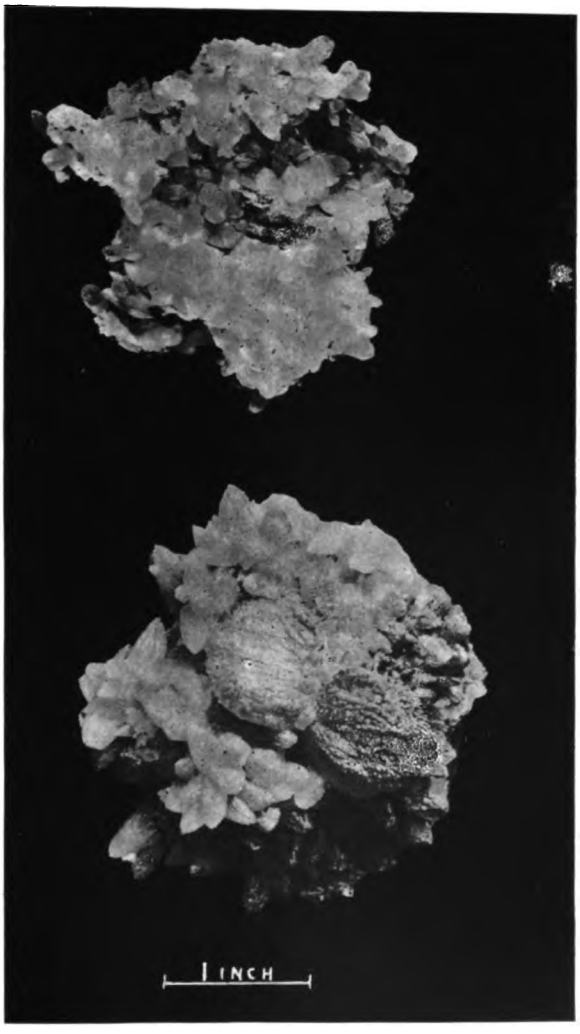


Fig. 1.—Crystallized Calamine, Proprietary Mine, Broken Mine.

Digitized by Google

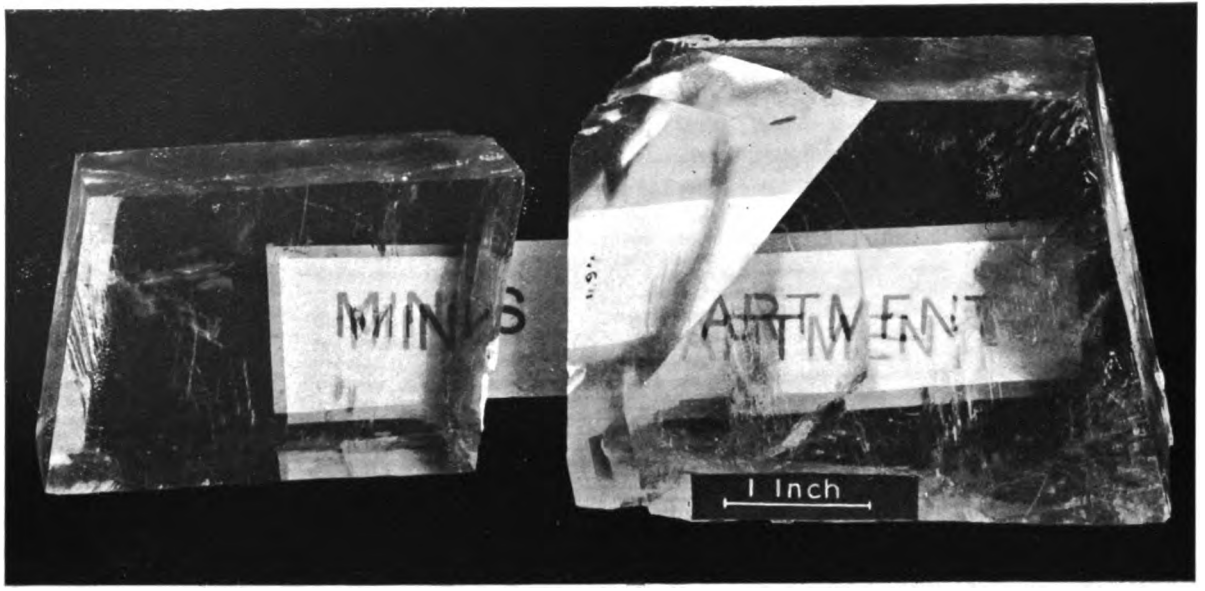


Fig. 1.—Calcite (var. Iceland Spar), Garibaldi Gold Mine, Lionsville

Digitized by Google

Upon some of the large crystals, short, stout hexagonal prisms of secondary calcite have been deposited. As single crystals and groups they are attached to the polished surfaces of the large crystals, and a very slight jar is sufficient to detach them from their smooth base. These groups are often very fragile owing to inter-crystallisation. The crystals forming them have flat terminations and vary to an inch in diameter, but there are probably others of larger size awaiting discovery. The position in which these crystals are found shows that the vugh was full, or nearly full, of water when they were formed At present there is very little in it, and it was noticed that the hydros were more likely to be found near the present water level than 2 or 3 feet above it. The vugh appears to have no connection with the auriferous vein.

As a part of the lode gangue, calcite is common in many mines, often in good rhombohedral crystals. In the Consols (Broken Hill) and Tulloch (Armidale) mines it is well crystallised and very similar in many respects, though the respective lodes differ widely. A secondary deposition which is still in progress may be seen forming stalactites and stalagmites of calcite in the old levels of the Wollondilly mine (Yerranderie). In the Consols mine a similar deposit was being formed on the footwall in an old stope, which was observed to gradually thicken over a space of some years. At the rate at which deposition was then going on, it was roughly estimated that possibly 400 years would be required to fill a fissure one foot wide.

In the Lucknow mines and the Consols (Cadia) it was associated with gold deposits. It also enclosed native antimony in the Consols (Broken Hill) and Reform mines (Lucknow). In the latter mine it was seen replacing fibrous serpentine, and some interesting pseudomorphs were then obtainable.

Very fine crystals of calcite have been obtained from the Belubula Caves (Mandurama). They were very perfect in form, of great purity, transparent or translucent, in single crystals and in groups. This occurrence has been described by Dr. C. Anderson*.

In Goodwin's molybdenite pipe (Kingsgate), crystals were seen occupying crevices between boulders and fragments of rock which formed the filling of an opening in the mine. This had the appearance of an old stope which had been packed with waste rock in the ordinary course of mining, and was so closely and uniformly arranged that it was difficult to regard it as a natural filling. The calcite crystals were doubly terminated, as were quartz crystals associated with them.

The Broken Hill lode contained a variety of forms of this mineral, stalactitic and stalagmitic, on psilomelane and limonite, in radiating masses and coralloidal groups, besides other varieties which, by reason of the presence of other bases in more or less quantity, formed distinct types. These were as follow :—

1. *Strontiano-calcite.*—In colourless to white crystalline globular clusters, made up of aggregates of rhombohedra, and found upon stalactitic limonite in the Proprietary mine.
2. *Zinco-calcite.*—In small white hexagonal plates upon stalactites of psilomelane from the same mine.
3. *Mangano-calcite.*—In stalactitic, coralloidal, radiating and massive forms with manganic-ironstone. Non-crystalline and clear pink in colour. Found in the South Blocks mine.

* Rec. Aust. Mus., 1920, Vol. XIII, No. 1, p. 13.

Digitized by Google

Limezinc Carbonate ($Zn CO_3 + 2CaCO_3$).—This mineral is placed here not because it is regarded as a variety of calcite, but because it somewhat resembles it in appearance and form. It appears to be a new species and was found in the Proprietary mine (Broken Hill) in 1897. Like several of the rare minerals of this lode, it was met with in very limited quantity in one locality. It occurred in white perfectly formed hexagonal tables about 4 mm. across, upon stalactitic psilomelane. It was analysed and found to contain the following :—

ZnO	23·67
CaO	32·42
MgO	2·52
CO_2	40·80
	99·41

Cerussite ($PbCO_3$).

Of all the secondary minerals of the Broken Hill lode cerussite was the most abundant, the most varied, and, in some respects, the most beautiful. The crystals were colourless or white, but were sometimes coated with a bright gold or red-bronze film similar to what was seen on some of the mimetite. Others were red or black, owing to an encrustation of iron or manganese oxide, but the great bulk of them were pure and free from colouring material.

Among the earlier discoveries the finest crystals were the long prismatic variety which projected from their base like miniature swords, and were seen in great perfection in the British mine. Smaller intermediate crystals completed the groups which were then of the greatest beauty, and being generally deposited in roomy vughs they were all terminated when they did not reach across the openings they were formed in. It was difficult to secure these splendid objects intact; they could only be removed with the utmost care in a manner which the circumstances of those days did not permit. It is doubtful if any of this type in an undamaged condition have been seen outside of Broken Hill.

The reticulated variety was found in the same area, but the best were probably from the Proprietary and Block 14 mines. This was composed of a number of blade-like crystals which were connected by many small parallel ribbons crossing and recrossing, and so forming a delicate and very beautiful network. The only blemish was in the fractured outside portion of the groups which had of necessity to be broken out of the surrounding mass. The full beauty of this variety could only be seen while it was *in situ*. The Writer in later years spent some hours endeavouring to secure similar specimens with the minimum of damage from vughs in the Central mine in which they had been found in profusion.

Long, thin, round crystals, each formed of an aggregation of very fine, almost acicular, prisms, giving to the crystals a fibrous appearance, were found in the Proprietary and British mines. They formed groups of isolated crystals which were sometimes roughly parallel, or perhaps crossed each other at all angles. These crystals resembled no other variety of this mineral found at Broken Hill.

Another definite type was a long dagger-like prism with wings projecting at regular angles and tapering away at the apex, in section showing a stellate form. These crystals were uncommon and fragile; it was most difficult to procure them in an undamaged condition.

Digitized by Google

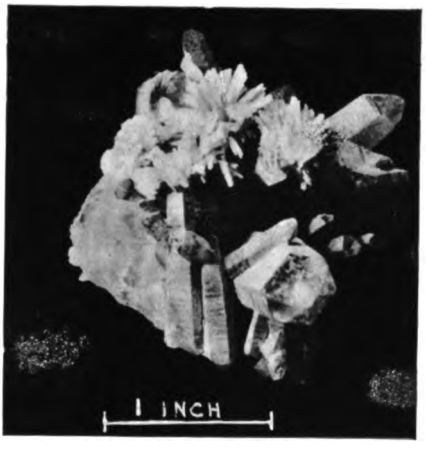


Fig. 1.—Cerussite crystals on Quartz crystals, Silent Grove, Torrington.

Fig. 2.—Anglesite crystals on Cerussite crystals, Central Mine, Broken Hill.

Digitized by Google

Digitized by Google

Beautifully perfect twin crystals, known as "arrowheads," were deposited upon some of the larger prismatic crystals to which they were attached at one side; they also formed groups attached to each other by their points or sides. The smaller crystals were colourless and the larger white; some were encrusted with small crystals of anglesite. A type consisted of long white, solid, smooth, enamel-like crystals which in section could be seen to consist of groups of elongated twins. Fine examples of this variety were found in the Proprietary mine.

A variety different from any of the others consisted of large groups of long and comparatively large round, tapering, single crystals which were covered with numerous small blade-like prisms standing out at right angles. Similar crystals without the prisms were sometimes encrusted with light green crystals of cupriferous calamine ($ZnCO_3$) and were best seen in the Proprietary mine among the earlier minerals. They were exceptionally long and of rare occurrence.

There were other forms; it would be tedious to mention them all, even if they could be remembered sufficiently to describe. Several are not represented in any collection known to the Writer. It is unlikely that all have been preserved, which is all the more regrettable, as their like may never again be met with.

There were many interesting and beautiful combinations with other minerals, the most valued being embolite crystals with their attractive waxy-like yellow-green aggregates upon the enamel-like crystals of cerussite. The embolite was not always distributed evenly, however, it was more frequently in bunches upon one portion of its base, and it was not a suitable mineral for exhibition owing to its liability to discolour on exposure. Anglesite, perfect in itself, covered groups of cerussite crystals equally good so thickly that the latter was sometimes lost to sight. It was deposited on the most fragile ribbon-like crystals of cerussite, and as it grew it became much larger than its base. In such cases the base was in places seen to have been ultimately removed, and the anglesite crystals which had at first been deposited in tiny individual crystals upon these delicate threads gradually became larger, and in spreading out eventually reached each other and by adhering formed solid groups which reproduced the original outlines of the cerussite without any replacement. Perhaps the most handsome of the combinations were pure white crystals of cerussite upon crystallised azurite and malachite. The former were seen associated in the form of twins attached at their points to a crosspiece passing between them, they then formed a group which in section showed six rays and were analogous to the stellate form previously described.

Pseudomorphs, after quartz, were found in the Proprietary mine, the angles and edges of the crystals being well reproduced. Masses of pseudomorphs, after an unusually coarse cubical galena, were seen in the same mine.

In the Gem mine (Apollyon Valley) a zone was passed through in which cerussite was sparsely distributed. This was largely in the form of twin crystals (arrowheads) and thin prisms. The whole of this ore was crystallized, the forms being very perfect, though small.

Large attractive groups of white crystals were found in the Mount Costigan mine (Tuena) consisting of fibrous-like prisms resembling some of the Broken Hill cerussite. These crystals were composed of bundle-like aggregates, formed by the massing together of small prisms, but in this case the

Digitized by Google

latter were of uneven length and the terminations were therefore irregular. In the mass they were probably the finest seen outside of Broken Hill, but their development was less perfect than the occurrences from that field. Groups of crystals of the same drusy character, much the same in appearance, were met with at Kangiara (Yass).

Prisms of cerussite associated with crystals of native copper were found in the C.S.A. mine (Cobar) in a ferruginous matrix. The copper had apparently preceded the cerussite in its deposition. At Silent Grove (Torrington) groups of quartz crystals were met with upon the apices of which were clusters of cerussite crystals of the "fibrous" variety, resembling those from Mount Costigan but much smaller and more perfect. Each compound crystal resembled a bundle of sticks of unequal length. Crystals of the stellate form were also seen in the Iodide mine (Condobolin), but they were not equal in any respect to those of Broken Hill, though they were well formed.

Of the massive occurrences there are two main divisions. Those which have been deposited as cerussite, and those which are the result of the oxidation of galena *in situ*. The first division is crystalline, the second earthy. Some of the outside mines of the Barrier Ranges produced quantities of the crystalline variety resembling the normal carbonate ore of the Broken Hill lode. The most important of these was the Southern Cross from which a regular output was maintained for several years, but it contained no large definite crystals such as were found in the Broken Hill lode. In the Wheal Angus, situated in another part of the field, the ore was of very similar type. There does not appear to be much variation in the ores of this class. Cerussite, impregnated with native silver in the North mine (Broken Hill) in the early years of the field much resembled the same class of material, with the same inclusion, found in the C.S.A. mine (Cobar) many years later.

The second division was shown in many mines, but it was unusual to find much clean carbonate of lead, there was more often a mixture or a core of sulphate or sulphide. The Richard Ruby mine (Apollyon Valley) contained the largest masses of cerussite of this class. These were obviously changed from galena that could still be seen in unaltered portions, but in this case there was no intermediate sulphate of lead. In the Thackaringa mines and in others on the Barrier field and elsewhere, galena could be seen surrounded by a black compact covering of anglesite, which in turn was enclosed in gray earthy cerussite.

The Cerussite of Broken Hill has been described by Dr. C. Anderson, M.A.*

Dolomite [(Ca Mg) Co_3.]

Groups of well developed colorless to white rhombohedral crystals of dolomite, single or in groups, occurred in the Proprietary mine upon rhodochrosite, limonite and psilomelane, but it appeared to be rather an uncommon mineral at Broken Hill.

In light brown crystals, some of which were hollow, it was distributed as small rhombohedra over crystallized marmatite in the Mount Stewart mine (Leadville).

A variety in which the ratio of $CaCo_3$ to $MgCo_3$ is high, is a constituent of the lode gangue of the United Miners mine (Major's Creek), and incidentally

* Jour. Roy. Soc. N.S.W., 1915, pp. 289-306.

Digitized by Google

is the enclosing material of many fine cubical masses of pyrite in that mine. It has been analysed by J. C. H. Mingaye and found to contain the following:—

$CaCO_3$	63·13
$MgCO_3$	29·40
$SrCO_3$	trace
$MnCO_3$	1·52
FeO	4·94
Al_2O_3	·40
SiO_2	·25
H_2O	·55
	100·19

Magnesite ($Mg\,Co_3$).

Very large deposits of magnesite formed of concretionary masses cover an extensive area near Fifield. It is also found in large quantities in the Barraba-Bingara district. As isolated nodules it is often met with in the alluvium at Tingha. At Woods Reef (Barraba) it occurs in the serpentine in odd bunches, and has been seen enclosing chrysotile. It is not uncommonly met with elsewhere, particularly in the serpentine rocks.

It is a particularly tough white mineral, and occurs in masses often showing good mammillated and botryoidal forms. It was seen crystallized at Bingara in shrivelled and somewhat distorted crystals about a quarter inch in diameter which appeared to be imperfect hexagonal prisms.

Breunerite—A ferriferous variety of magnesite. In small yellowish-white crystallized groups, it occupied cavities in basalt with natrolite in the Elsmore-Newstead Junction Shaft (Elsmore). It was analysed by H. P White with the following result:—

$MgCO_3$	42·79
$CaCO_3$	46·07
$FeCO_3$	7·39
$MnCO_3$	·08
FeO	·30
Al_2O_3	.30
H_2O	1·22
Gangue	2·20
	100·35

Malachite ($Cu_2CO_4 + H_2O$).

The finest crystallisations of malachite were probably seen in the Great Cobar mine, in which there were masses of the fine acicular variety with the coarser fibrous aggregates which were sometimes in unusually long crystals. The latter formed radiating clusters that occasionally were quite circular. Mammillated masses occurred in crevices in the lode, and these generally enclosed loose fragments of quartz, apparently embedded during the process of crystallisation.

Similar varieties were found in the Mount Hope mine which also yielded fine pseudomorphous crystals, partly or completely changed from azurite.

In the West Bogan mine (Tottenham) a variety consisted of smooth mammillated masses composed of alternate green and almost black layers, very compact and capable of receiving a good polish. It possessed a bluish tint and was much darker than the Burra malachite (South Australia), though apparently equally suitable for ornamental purposes.

The botryoidal type was seen in the Copper Hill mine (Molong) where it consisted of crystalline fibrous radiating layers. Some of the groups

Digitized by Google

had been corroded, generally the most prominent. The corrosion had penetrated through several layers and seemed to have been concentrated at certain points.

Silky radiating clusters of crystals were found in the Kyloe mine (Drake) deposited upon azurite. In small quantity it was met with in many localities.

In the Broken Hill lode malachite was most frequently observed in mammillated forms, the deposits being smaller than at Cobar. It was silky and compact, but was not seen in the coarse radiating forms of the latter field. In colour it was variable, ranging from light to dark green, and often invested with crystals of cerussite, azurite, or embolite, each perfect and all forming combinations that were as interesting as they were beautiful. The finest were probably met with in the Proprietary mine, but the largest masses seen by the Writer were from Block 14, these were covered with twin crystals of cerussite, and as they resembled masses of dark green plush they formed very choice specimens.

Pseudomorphs after azurite, of finer quality than at Mount Hope, were found in several of the Broken Hill mines though they were not common. They were of prismatic habit, generally pseudomorphosed in parts; some were completely changed, while others in the same cluster were unaffected. The crystals were often much larger than those of Mount Hope, and they possessed the high polish and great perfection that so characterise the Broken Hill minerals.

The velvet-like variety was represented to perfection in the Umberumberka East mine (Barrier Ranges), where it encrusted joints in the rock, large flat slabs were coated with a beautiful fibrous covering without a blemish. This deposit was the more interesting through its association with many perfect crystals of atacamite which were distributed over it.

The amorphous varieties were of common occurrence in many localities. The most interesting were those of the Cobar-Mount Hope district, in which veins and bunches of malachite of the earthy variety were found in association with azurite and chalcocite, and often cuprite, in similar forms impregnating white clay, the whole forming very attractive combinations.

Phosgenite ($PbCO_3 + PbCl_2$).

This rare mineral was found in the Consols mine (Broken Hill) accompanied by cerussite and vanadinite in a gangue of limonite. It occurred in one section of the mine only in short stout tetragonal prisms, showing good basal cleavage, and was colourless to yellow-white. In the amorphous form it was met with in small quantity in the Day Dream and New Year mines (Apollyon Valley).

Rhodochrosite ($MnCO_3$).

Rhodochrosite occurred in the Broken Hill lode in globular crystalline groups coated with dolomite, and in mammillated and spheroidal forms. It was seen in several mines of a fawn colour deposited upon manganic-ironstone, the finest examples probably in Block 10, but it was rather uncommon in its crystallised forms. In the Junction North it coated large crystals of siderite and, as the amorphous variety, it also occurred in the Junction and Central mines.

This mineral has recently been found in larger crystalline masses with calcite and various sulphides in the South Blocks mine (Broken Hill). The latter discoveries are pink in colour, and unlike the globular forms met with in the shallow oxidised zone.

Digitized by Google

Digitized by Google

Fig. 1.—Crystallized Siderite, Aust. B.H. Consols Mine.

Fig. 2.—Crystallized Siderite, Mount Stewart Mine, Leadville.

Digitized by Google

Siderite ($FeCO_3$).

Siderite is the chief constituent of some lodes, with calcite often forming alternate but irregular bands with bunches of ore, most commonly galena, in the centre. The best example was seen in the Consols mine (Broken Hill) where it was exceedingly pure and clean, and in its association with calcite and various metallic minerals presented an interesting illustration of vein-filling. It also formed the lode gangue in other mines in which it was mixed with sulphide ores, as at Umberumberka, Thackaringa, and other parts of the Barrier Ranges field, and Yerranderie. It was met with in all stages of oxidation, and well-developed crystals were found in several mines. In the Consols it formed groups of rhombohedral crystals more perfect than any seen elsewhere. At certain levels they were red-brown owing to incipient oxidation; at lower levels they were unaltered and in places dusted over with small crystals of pyrite. Vughs containing these fine crystallisations had been filled with dyscrasite which had taken an impression of the crystals. Some of the vughs had been partly filled with calcite, and the two minerals were crystallised together. In the oxidised zone there were many openings from which the calcite had been dissolved and the siderite remaining had been pseudomorphosed to limonite.

Good crystallisations were also seen in the Day Dream mine (Barrier Ranges) forming groups of flat rhombohedra in vughy parts of the lode. Similar groups were found in the Mount Stewart mine (Leadville) and, on a smaller scale with chalcopyrite and quartz crystals, at Drake. With antimonite at Hillgrove also, all being in perfect forms. Clusters of large flat rhombohedra coated with rhodochrosite were met with in the Junction North mine (Broken Hill).

Digitized by Google

PART II.

1. MINERALOGY OF THE BROKEN HILL LODE.

(*a*) CHARACTERISTICS.

The chief characteristics of this lode were the variety, purity and perfection of its secondary minerals. As a result of re-deposition they were crystallized and easy to investigate (some of the mercury compounds were exceptions). In the outside mines (the Consols excepted) the more uncommon ores were often so mixed that it was difficult or impossible to determine what the individual minerals were. Except in the case of some of the silver chlorides and a very few others, the minerals of those mines had been altered *in situ*, and in consequence were generally impure, rarely crystallized, and always less interesting.

The earthy variety of lead sulphate which forms the intermediate ore between galena and the outside crust of carbonate in so many places, was not observed in the Broken Hill lode. The oxidation of lead sulphide under normal conditions would appear to be a gradual process, in some galena lodes the ore, practically unaltered, is present in the outcrop. In the Broken Hill lode disintegration of the sulphide would be hastened by the solubility of the zinc sulphate when oxidation had commenced. Evidence of this was shown by the leaching that had occurred at the junction of the oxidised and sulphide zones resulting in the removal of the soluble portions, and leaving masses of siliceous material representing the insoluble residue of the original ore body. Incidentally upon this skeleton many fine groups of pyromorphite and anglesite crystals were formed. This was an extreme case of leaching, but there was a zone of alteration between the oxidised and sulphide ores in which the latter had been subjected to some action by solutions which had enriched them in their silver content and would perhaps have eventually caused, or at least assisted in bringing about, their disintegration, but sulphates were either absent or very rare and carbonates did not exist in this class of ore.

The silver minerals and the oxidised lead ores had a more widespread distribution than the other minerals which being more restricted in their occurrence were, in many cases, confined to certain zones. These zones corresponded in the respective mines more in degree of oxidation than in actual depth, so that they were not necessarily of uniform depth throughout. There were variations in mineral character representing what might be described as mineral subdivisions within a zone. This was not indicated only by slight variations in the general character of the mass of the lode, but by a rough grouping of certain minerals also. This is not intended to suggest that the minerals of a particular class were confined to certain depths, though it was true of some that were found at shallow levels, but rather that those which occurred at widely different levels showed some variation that was characteristic of the depth at which they were formed. The pyromorphites were the best illustration of this. The brown or gray-brown varieties were the deepest as they occurred near, or in actual contact with the sulphide ores, and were not found in the upper levels. Other varieties were associated with the shallower oxidised ores and did not extend far downwards. These differences probably denoted variations in composition which were due to the conditions that prevailed at the time of their formation in the positions where they were found.

Digitized by Google

Several of the mines contained minerals which were peculiar to them. Nantokite and boleite in the South, the secondary minerals of Block 10, wulfenite and the calamine-native silver combination of the Junction, linarite (in quantity) of the British, stolzite and raspite of the Proprietary were examples. The copper minerals and pyromorphites found in different mines were, in places, distinct from each other. Even in contiguous mines like the Proprietary, Block 14 and the British, which presented many similar mineralogical features, there were often diversities in the commonest types by which it was possible to refer minerals to their sources at sight by difference in form, or perhaps by some characteristic due to association of matrix or other minerals.

The greatest dissimilarity of Broken Hill types was shown, however, by the minerals of the Broken Hill and Consols lodes. The former, though it has yielded many thousands of tons of silver is yet not a silver lode, the silver is incidental. The Consols, though insignificant by comparision, is essentially a silver lode in which base metals formed a very small part. No definite silver sulphide mineral was known to the Writer in the Broken Hill lode, and no cerargyrite, though embolite was so plentiful. In the Consols lode silver sulphides were numerous and cerargyrite also, but there was no known chlorobromide. The respective lodes seem to be the complement of each other, what one lacked the other possessed, the only silver minerals known to be common to both being iodyrite and native silver.

If a comparison be made of the silver minerals of the Broken Hill lode together with those found in the whole of the outside silver and lead mines of the Barrier Field, and at the time the Writer knew them there were over 100 in being, it will be seen that there were twice as many in the Consols as in all the others combined. It was in the general excellence of its secondary minerals that the Broken Hill lode was pre-eminent and unapproachable, but its range of silver minerals was very limited.

(*b*) SEQUENCE.

The opening of the oxidised portion of the lode disclosed a wealth of secondary minerals which perhaps has never been surpassed in any one deposit. The loose vughy nature of the ore body permitted of the ready percolation of solutions which left few openings without crystallization of some kind. The upper part of this zone was the most interesting because the minerals found there were more varied and rare than those obtained from lower levels though in similar oxidised material.

In describing their sequence it will be understood that this refers to the order in which the minerals were observed, or collected, by the Writer as the workings were extended into lower levels, and is not in any way related to the order of their deposition. As a matter of fact many which were first met with belong to the later depositions, as could be seen by their relation to other secondary minerals and also by the perfect condition in which they were found. The vanadates and arsenates of lead and some of the silver compounds were of this class. Having been deposited in open spaces they were exposed to the action of passing solutions, but only in exceptional cases was there any evidence of chemical action upon them, and no later earthy deposits which so often disfigure minerals in vughy ground. It appeared evident however, that the solutions had been variable in composition and intermittent even within confined areas, and therefore, while some deposits escaped any action from them,

Digitized by Google

others in the vicinity were attacked. As an illustration of this with recurring conditions the following may be mentioned. In the Proprietary mine large crystals of azurite were so corroded that their apices were removed, in some instances only the stumps remained. What was apparently a later deposition of smaller but even more perfect crystals was found in the vicinity. These had been acted upon in a different way, many of the crystals being partly or completely changed to malachite. The earlier crystals were corroded but not pseudomorphosed, with the others this action was reversed. Some of the mimetite groups had been subjected to similar action resulting in a portion of the crystal groups being removed, but in their case there was no later deposition.

Masses of cellular and mammillated psilomelane encrusted or impregnated with embolite found in the outrop were among the earliest discoveries, but soon after cerussite and calamine were met with also invested with embolite. The rich yellow-green colour of these shallow deposits was more pronounced than the lighter coloured embolite met with in later years in the siliceous ores of lower levels; difference of gangue was responsible for many minor variations in the associated minerals. Stalactites of psilomelane followed in considerable quantity encrusted with embolite or calamine. Some of the stalactites had been formed upon a small original nucleus of limonite which however also formed separate stalactites, but was less frequent, and the investing minerals did not so readily attach themselves to its more earthy structure. Many of the vughs containing these minerals were fairly large and very beautiful in their general perfection. The colourless or white brilliant crystals of the investing minerals, accompanied in places by the yellow-green embolite, contrasted well with the black stalactites.

Several years later larger vughs at lower levels were met with containing a much greater number of stalactites. One vugh as large as a room contained so many that it was difficult to move about in it. The stalactites were of psilomelane much more thickly encrusted than those above with white crystalline calamine resembling a covering of snow. Some were at least seven or eight feet long and a foot in diameter, where two or more had joined they were much larger, those which were connected with stalagmites formed large columns. The floor consisted of nothing but calamine; there were many stalagmites of all sizes. Many of the stalactites obtained ranged from a few inches to two feet or more in length, some were a foot long although only half an inch wide. No other minerals were present and every portion of the vugh was unsoiled and undamaged. It was the Writer's privilege to spend some hours in this vugh as soon as it was opened sufficiently to admit of entrance, and so far as he knows no other specimens were taken from it, though great numbers were available. With stoping in progress all round, this most interesting deposit was quickly destroyed. Though the finer individual translucent crystals of calamine were lacking, it was, having regard to its size and unblemished condition, the most beautiful and impressive mineral occurence ever seen by the Writer.

Contemporaneously with the earlier deposits the most perfect crystals of cerussite were found in large quantities, many being encrusted with embolite. Some of the more massive kinds contained the pretty turquoise-blue chrysocolla which though observed in several mines was not at all common, and the deposits of it were small in each instance.

Somewhat later linarite was discovered upon the roof of a large vugh in the British mine, the largest seen in this lode and responsible for the great "creep"

Digitized by Google

which occurred in that mine some time later. It sloped away at a fairly flat angle and was low enough in parts to admit of the crystals of linarite and other minerals associated with it being reached by hand from the floor. A number of boulders naturally deposited on the sloping floor when disturbed could be heard clattering down to what appeared to be considerable depth. In later years this mineral was found in the Proprietary mine, but the quantity was exceedingly limited.

At the same time (April 1883) a very bright canary-coloured variety of pyromorphite with hollow crystals, the first appearance of this mineral, was seen in the carbonate stopes of Block 14. Yellow-green crystals of the same mineral were met some time later as a lower level in several mines, but they were of a different type. The canary-coloured crystals, which were distinguished by very smooth surfaces and rich color were not seen again, there appeared to be but one occurrence of them.

Embolite occurred in profusion in many different gangues, the kaolin deposits being exceptionally rich in that mineral. Iodyrite had been found in the Central mine, but was known so little that it remained unrecognised for some time. Eventually it was observed in many places, particularly as an impregnation in kaolin. Native silver also had become general through discoveries in several mines. In the Junction mine quantities were seen upon calamine, which, as a crystalline deposit, lined open spaces in the lode, in lower levels it had been decomposed and partly removed, and upon the ruins the silver remained as a gray powder. Thick flakes and films enclosed in kaolin, together with films and crystalline wire-like masses in limonite were noted also.

New and interesting minerals approximately contemporaneous with each other were identified, among them the arsenates and vanadate of lead, uncommon minerals not met in many places—especially the latter, which was rare, and like several other minerals of this period, was confined to one part of the lode. The cupriferous calamine belonged to this section and though there were several varieties they occurred in small masses and never in large quantity like the white or colourless types.

The oxidised ores of copper were associated with the minerals of the upper levels, malachite being rather common in several mines in mammillated masses encrusted with crystals of azurite, cerussite, or embolite. Native copper had been seen in some quantity in the British, but the finer crystallisations were found at a later date in the Proprietary and Block 10 mines, in the latter they were rather plentiful in masses and handsome groups of wire-like crystals.

Cerussite was the common associate of all these minerals and none showed such variety of form or more perfect crystallisation. The finer groups were very fragile and it seemed impossible to secure them intact. Occasionally clusters were observed in openings in manganic-ironstone which could be removed without damage, but in most cases, they formed a part of large masses from which they had necessarily to be broken. The largest mass of crystals of cerussite seen by the Writer, probably the largest known at Broken Hill, occurred in the Central mine, where it formed a solid deposit underlying the sulphide ore. This occupied an oxidised channel which had been formed in the sulphide ore by the downward passage of surface waters. A large stope in the middle of it exposed nothing but pure white crystallised material, the forms of the crystals resembling those found at shallow levels in the other

Digitized by Google

mines several years earlier, but they were distinct from the others by reason of a slight gray-blue tint which was due to their close association with the surrounding sulphides. The dagger-like crystals of this deposit were unusually long and so interlaced by delicate filaments that it was impossible to secure any groups in an undamaged condition, though every convenience was provided for the purpose. As a huge mass of crystallised material it was not surpassed by any deposit of ore in this lode. The splendour of such a body of almost transparent or translucent brilliant crystals, spread over such a wide area, could not be realised from individual specimens, beautiful as many of them were.

Marshite had been found in the Proprietary mine but was still a rarity It became known more generally as discoveries were made in other mines' but the total quantity was very limited. The mercury compounds followed, except the yellow powdery form which was identified as tocornalite and was not seen until much later. These were impregnations in kaolin and were said to include onofrite, the sulpho-selenide, but this was never verified.

An unusual form of galena had been met in the South mine consisting of plumose masses of secondary deposition occupying openingsin the lode. As a variety of galena it was new to the field and perhaps because of its form and the fact that it contained a little antimony, it was classified as boulangerite. A sample taken by the Writer at the time assayed about 80 per cent. lead, and 2½ oz. silver. In after years it was noted in many other places in the Broken Hill lode. Its secondary character was well shown by its occurrence in vughs following cracks in the enclosing gangue. In crystalline groups it was seen deposited upon crystals of pyromorphite and cerussite.

Wulfenite had been found at the 150 feet level of the Junction mine in a large stope from which, at the time of the Writer's visit, the miners had been withdrawn owing to the presence of carbon-dioxide. Access to the crystals was difficult though they could be seen glistening in small vughs 15 to 20 feet from the main level with which the stope was connected, and where the ventilation was good. In these circumstances it was only possible to reach and quickly break out the crystals in what was literally a breathing space. It was impossible to select the best or work any of them out, and in consequence, few, and those not of the larger groups, could be secured. When ventilation was restored and work in this stope was resumed very few examples of this rare mineral were saved. Like many other unique occurrences in this lode it was destroyed because no one in authority was interested sufficiently to have it protected. Quite recently a further discovery has been made in the same mine at the same level, nearly thirty-five years after it was first found. It is believed that this occurrence is the only one of its kind yet discovered at Broken Hill.

Though manganese oxide was present in such great quantity in the outcrop and shallow levels, there was comparatively little in the lode between this upper zone and the level at which rhodonite occurs. Occasional groups of rhodocrosite crystals were found, but this was an uncommon mineral, as the groups were isolated and never large.

Anglesite was fairly general in its occurrence, but it was not seen in large quantity until the mines had been worked for a considerable period. The first crystals found were almost colourless, in lower levels they were of sherry colour. In the Central mine a large stope in a mass of cerussite had many

Digitized by Google

cavities in which were very perfect crystals of this mineral and upon them were large quantities of equally fine single crystals and clusters of anglesite. These in places surrounded the points of the cerussite crystals and were then found to contain $PbCO_3$ though they were typically anglesite in form. These particular crystals were described by P. T. Hammond* of this Department, and analysed by J. C. H. Mingaye with the following results:—

	No. 1.	No. 2.
H_2O	nil	nil
PbO	74·11	74·11
SO_3	22·27	25·00
CO_2	3·32	1·34
	99·70	100·45

Mr. Hammond has described mistakenly this mineral as having been found in the Consols lode. As a deposit of crystals it was characteristically free from mixture with other minerals and like similar occurrences was on a grand scale that could be possible only in a large ore body. The perfection of its crystals, their vast number and their purity and lustre, place them in the front rank of such magnificent deposits.

The sherry-coloured crystals were not found until 1896-7. They were of the largest type and were very plentiful in Block 14. These crystals, which were probably the most lustrous of all the Broken Hill minerals, occupied a large area and presented a wonderful scene of sparkling beauty that was accentuated by the dull gray of the surrounding partly altered sulphide ore. They were not attached to the more fragile carbonate in small groups as was generally the case, but could be obtained in thick solid masses of which there was no portion that was not crystallised. They could be sawn into sections so that any particular group might be secured. Only a few pieces of this beautiful material were collected although tons of it were readily available.

Pyromorphite of the crystallised type, since its early discovery in Block 14, was observed in many places even to the confines of the sulphide ores. In colour it varied from yellow to greenish-yellow and gray to brown and perhaps almost colourless, according to depth and probably to variations in composition. The only amorphous type was found in the outcrop in which it occurred in immense quantity. In 1894 magnificent red-brown crystals were met with in Block 14 nearly a quarter inch in diameter, the largest seen to that date. Prisms of greater diameter have been found since, but they were short and otherwise less perfect. Very little is known generally of its composition, the solutions from which it was deposited would probably not have corresponded at all depths at which it was found. Evidence of this would be indicated not only by differences in composition, but also by modifications of form; it is, however, always a mineral of varying composition. The Block 14 (1894) deposits were in vughy ground and large openings were lined with beautiful clusters of crystals each of which was a perfect prism. They did not possess the lustre of anglesite, but as large masses of the finest crystallisations they were equalled by few others. At the bottom of the oxidised zone pyromorphite in botryoidal and mammillated deposits was connected directly with the sulphide ores. Although these masses were excellent examples of their kind, they lacked the attractiveness of the definite crystal forms.

* Rec. Geol. Survey, N.S.W., 1895, Vol. IV, Pt. 4, p. 168.

Digitized by Google

Nantokite was one of the later discoveries and there was but one occurrence of it. Stolzite was observed some time after and still later raspite and mierite were found. Boleite was the last of the rare minerals to be identified to the time of the Writer's departure from Broken Hill in 1898. Each of these minerals was found in very small quantity except stolzite, of which there were several deposits of different types. In common with several other rare species occurring in definite varieties, these deposits were never investigated properly. In form and colour stolzite was even more distinct than were the different varieties of pyromorphite and mimetite. Owing to their rarity it is unlikely that supplies of its five definite types could now be obtained for investigation.

In the aggregate a considerable quantity of gold was obtained in smelting, but it was very difficult to detect free gold in the ore. The Writer has, however, seen specks in limonite from the shallow levels of the Proprietary mine.

Excepting a few less important minerals which are described under their headings elsewhere, this completes the mineralogy of the oxidised zone. With the passing of the secondary minerals consequent on the practical exhaustion of the oxidised ores, the less interesting sulphide era was entered upon, and thus the mineralogical glory of this wonderful mineral deposit came to an end.

(c) IDENTIFICATION.

It was not the general practice at Broken Hill to proclaim the discovery of new or strange minerals. As they were found they were investigated: the results might be imparted to those interested, and they formed a very small body, but it was seldom that the new minerals were formally recorded. Thus whereas several minerals had been recorded by outside observers as new discoveries, in reality they long before had become a part of the mineral history of the field. Spessartite was collected in 1886 and identified a little later. Rhodonite had been recognised, and its occurrence as a constituent of the lode was a matter of common knowledge in 1889-90.

Iodembolite, described by G. T. Prior, M.A., and L. J. Spencer, M.A.,* in 1902, had been determined in Broken Hill about ten years before. It was one of the earlier haloid minerals of shallower levels. Professor Liversidge† was probably the first to detect iodine in appreciable quantity in silver chloride, but the locality of the mineral was not stated. Messrs. Prior and Spencer have noted this fact.

Willyamite was forwarded to the Royal School of Mines as a new discovery in 1899, notwithstanding that it had been recorded by E. F. Pittman, A.R.S.M.,‡ then Government Geologist, at the request of the Writer six years earlier.

Raspite had been determined and recognised as a new form of stolzite some months before the arrival in Australia in 1895 of Baron H. Foullon-Norbeeck, an Austrian scientist. The Writer discussed this mineral with him on his visit to Broken Hill. The Baron was killed on his return journey to Austria, but his collection was sent there and found to contain the new mineral, which was investigated and recorded by Dr. Hlwatsch§ in Vienna long after.

* Min. Mag., 1902, Vol. XIII, No. 60, pp. 174-185. † Jour. Roy. Soc. N.S.W., 1888, p. 88.
‡ Jour. Roy. Soc. N.S.W., 1893, pp. 226-8. § Rec. Geol. Survey, N.S.W., 1898, Vol. VI, Pt. 1, pp. 57-61.

Digitized by Google

The identity of the discoverer of miersite is not known to the Writer, but the identification of that mineral as a new species was a matter of common knowledge long before his (the Writer's) departure from Broken Hill in 1898.

A number of rare minerals were recorded in Broken Hill as having been found there about 1889-91. In the succeeding years many of these could not be traced and it seems probable that some at least were classified incorrectly. The following might be specially mentioned:—Freieslebenite, polybasite, jordanite, jalpaite, sartorite, matlockite, lanarkite, erinite, atlasite, onofrite, boulangerite, pilarite, aurichalcite. Some of these were probably secondary mixed sulphides from Block 10, others may have been from the outlying mines in which were several indefinite silver-lead-antimony sulphides. "Onofrite" occurred as a dark gray impregnation associated with the red mercurial compounds found in kaolin, "boulangerite" was the plumose variety of lead sulphide, "aurichalcite" was the cupriferous calamine, and "pilarite" was a variety of chrysocolla, of which some of the forms found during the earlier stages of mining contained a small quantity of alumina.

The absence of verification might, however, easily be due to lack of material as several of the rare minerals were observed in extremely limited quantity. Raspite and miersite were in crystals too small to attract ordinary attention, even if they had been distributed more widely. Only one deposit was found of nantokite, boleite and other minerals, and in each case the supply was very small. Camphylite was such an attractive mineral that it would have been collected in quantity had it been available, but only two specimens were known to the Writer and they were probably from the same occurrence.

Other minerals determined over thirty years ago, of which all records of tests or analyses have been lost, are caledonite, brongniardite, bromyrite, and antimony oxides; in consequence they are not included in this book. Hedyphane probably was classified correctly, as some of the white mimetites are known to have contained CaO. The particular deposits in which these doubtful minerals were found have been exhausted long since, so it seems improbable that further supplies for determination can ever be obtained.

(*d*) OCCURRENCE OF GARNET.

When an early shaft of the Proprietary mine first entered rock where the continuation of the lode was expected to occur, and which proved subsequently to be the centre country dividing the lode, it was believed that a large slab of ground had fallen from the hanging wall. The garnet in the lode was then explained as a residual of this country rock after its replacement by ore. Later, as replacement of the lode walls became recognised, and the general occurrence of garnet in the lode was noted in quantity comparable with that in the enclosing rock, the opinion that the replaced rock was its probable source became strengthened. The gradual transition from ore to normal country rock could be plainly observed in crosscuts. Had garnets of the type associated with the country rock occurred within the replaced zones they should have been visible, but the Writer has no recollection of having seen them under such conditions.

The lode garnet was found first enclosed in cerussite of a yellow to red-brown colour, always well crystallised, highly polished and much fractured, while a variety in the gneiss enclosing the lode was dark rose-red, amorphous, less fractured, and in comparatively small fragments. The lode garnets

Digitized by Google

contained visible amounts of cerussite which had been changed from galena, and probably their fractured condition was due in large measure to the shattering effects that oxidation of the sulphide would cause. Small crystals also enclosed in cerussite without such inclusions were intact, of deeper colour, and in a much better state of preservation generally. They were abundant in some masses of kaolin.

In later years the unaltered, though much fractured garnet, in crystals as much as 3 or 4 inches in diameter, was met in the sulphide zone of darker and richer colours, enclosing fragments and even small cubical masses, of galena with other metallic sulphides, and sometimes itself entirely surrounded by galena. These inclusions are generally in the form of films and may be seen in the cleavage joints of the garnets. Some of the crystal faces of the latter show pitting due to corrosion. The larger crystals are much flawed, but there are some of smaller size which are transparent and of much superior quality to those which in the shallow levels had been subjected to oxidising influences.

In the very early days of smelting at Broken Hill the gneiss forming the western wall of the lode was much broken and powdered by traffic to the smelters. The rock garnet could then be seen in the dust, but obviously it was of different type to the variety found in the lode. An analysis of each has been made by H. P. White and is furnished for comparison. No. 1 is from the Junction North mine, and No. 2 from a position about 2 miles north-east of Broken Hill :—

	No. 1. (Spessartite).	No. 2. (Almandine).
SiO_2	36·16	38·12
Al_2O_3	19·40	19·71
Fe_2O_3	.....	6·70
FeO	9·81	27·63
MnO	28·10	2·05
MgO	·12	3·22
CaO	3·38	1·14
Na_2O	·17	·69
K_2O	·17	trace
H_2O+	·31	·58
H_2O-	·03	·04
CO_2	·13	.....
TiO_2	·04	·47
S	·17	.....
PbS	2·03	.....
P_2O_5	trace	.....
V_2O_5	trace	.....
	100·02	.....
Less O equivalent to S	·12	.....
	99·90	100·35
Specific gravity	4·194	not recorded.

Accepting these garnets as representative of the lode and rock varieties respectively, the analyses indicate distinct mineral types. The differences in form, size, colour, and composition are marked clearly and definitely. Spessartite has not been recorded as a rock mineral at Broken Hill, while almandine is unknown in the lode and does not contain metallic inclusions. Its envelopment by crystalline masses of galena and its enclosure of that mineral would seem to indicate that spessartite was of contemporaneous crystallisation and a result of the reconstruction of the lode material in common with other of its associates.

Digitized by Google

(e) RE-DEPOSITION.

The crystallisations of Broken Hill and Cobar were due to leaching of very unattractive ore bodies and the subsequent redeposition of the material. They were all confined to the oxidised zone, however, and it is now proposed to refer to some silver minerals which are regarded as having been derived from the same source and are also of secondary deposition, though found at various depths below the water level. These were all sulphides, the only form of these secondary ores besides native silver, which were found in the upper part of the sulphide zone. Unlike the silver haloid minerals which are confined to oxidised areas, the sulphides are met with both above and below the water level.

The ores of the Consols mine (Broken Hill) afforded the best examples of such secondary deposition. They were proved to continue for some distance into the unaltered zone, as appears to be usual with such ores, and gradually lessen in depth; but as they have been described in the chapter devoted to that mine and there were no definite silver sulphides known in other mines of the Barrier Ranges, the field will be enlarged so that an occurrence beyond Broken Hill and the surrounding district which bears on the subject may be included.

The Tulloch mine (Armidale) may be chosen for the purpose of illustration. In this mine the lode is of unusual character as a silver deposit, as it is composed of mispickel, argentiferous in itself, and enriched by inclusions of tetrahedrite. The mispickel was much altered above the water level and secondary deposits of silver chloride were present in the usual encrusting and impregnating forms. At and below the water level the secondary ores consisted of native silver and pyrargyrite associated with small quantities of pyrite, blende and galena, which are regarded as primary ores. These two silver minerals were found in vughs or joints in the mispickel, or more commonly in calcite enclosed by the mispickel, and were responsible for the increased values of the ore. The amount of silver present would, however, have been greater had silver chloride been the enriching mineral. Native silver and the sulphides are deposited in openings and joints, the chloride occurs similarly, but it also impregnates the mass which the others do not, or, if so, to such slight extent as to be hardly appreciable. The presence of of the chloride, therefore, indicates higher assays as an impregnating medium.

The pyrargyrite and native silver may be expected to decline in quantity as further depth is attained, though in the Consols mine the former mineral was found to continue far below any of the other silver sulphides. Though there was no resemblance between the lodes in these mines the results of their alteration were much the same. In each mine, enrichment was shown by concentrations of secondary minerals, and their future seems to depend on the original value of the lodes with whatever additional value the ever-waning secondary enrichment may have left. The lode in the Tulloch mine in its deep levels should therefore consist of solid mispickel, with some quantity of other base ores, somewhat enriched by tetrahedrite, while in the Consols it is known to consist of siderite and calcite with erratic deposits of dyscrasite and tetrahedrite. The former is apparently approaching the point beyond which no secondary minerals will be seen; the latter probably reached it before operations were suspended.

Digitized by Google

The impregnation of its gangue by silver chloride was seen in practically all the silver mines of Purnamoota, Apollyon Valley, and Mount Gipps. The gangue was limonite, which in the vicinity of the rich bunches of cerargyrite was often of high silver value, though no primary ore which would account for it might be visible. Any doubt as to its payable nature would be dispelled generally by the appearance of specks or films of the chloride. Native silver could be present in the same class of gangue in solid form, but the latter might yet contain no appreciable value of its own. The Eaglehawk mine (Broken Hill) yielded lode material containing coarse native silver, but the bulk assay of the richest parcel was 60–70 oz. Native silver is like free gold—practically the whole of it can be seen. Chloride of silver may be present in much greater quantity and yet be invisible. Argentite and pyrargyrite may also show through the gangue, but they do not permeate it like the chloride.

Much irregularity is shown in the depths to which the various silver sulphides extend. Depth, however, in this connection is a relative term which varies according to circumstance. Surface influences may continue unexpectedly to low levels, as was shown by the great masses of pure cerussite which were found underlying sulphide ores in the Broken Hill lode. Stromeyerite and argentite did not continue below water level and the other sulphides seemed to be confined to the upper part of the sulphide zone. Pyrargyrite was the most persistent, but where it has not already been lost in the mines referred to, its end appears to be in sight. It therefore seems probable that the minerals recorded—stephanite, stromeyerite, pyrargyrite, argentite, sternbergite, and proustite—which in the Consols mine were found at comparatively high levels, should be regarded as secondary. Some may continue downwards to a considerable depth, but it would be in diminishing quantity.

Tetrahedrite is not a definite silver mineral, although it is found in many places to be richly argentiferous; it is often associated with those ores, but appears more permanent. It has been found in the deepest levels yet reached in circumstances that remove it from the class represented by the silver sulphides. It occurs in the siderite in deep levels in the Consols mine, in solid galena at Yerranderie and Umberumberka, and in the unaltered mispickel of Armidale. If it is not a primary mineral, as appears most probable, it must be placed in a class distinct from the other sulphides of silver, which have not, in the localities referred to, shown the same indications of permanence.

In several of the mines in the Purnamoota district bunches of exceedingly rich silver-lead-antimony sulphide were enclosed in limonite. Probably they had existed as original ore bodies in the siderite before its oxidation. No doubt others had existed also, which had been removed or replaced by cerargyrite, and some of these replacements were still to be seen. They formed rich concentrations which, as previously stated, eventually became "slugs," of which so many were found in the early days of Silverton. These sulphide ore bodies were not known to continue below the water level, though little was ever done to prove their downward extension. When water level was reached silver chloride disappeared, siderite replaced the limonite, and galena in unimportant quantity was met in many places. This was regarded as an unfavourable combination which discouraged

Digitized by Google

deeper exploration. The following partial analyses indicate the value of these silver sulphides, but they were variable in composition :—

	No. 1.	No. 2.
Ag	20·94	26·24
Pb	51·80	41·25
Fe	2·70	.....
CaO	2·45	.....
Insol.	5·90	.....

The most interesting mine on the Barrier field outside of Broken Hill was the New Year (Apollyon Valley), in which more native silver was found than in all the other outside mines combined. The gangue was limonite, but it was not argentiferous to appreciable extent. There was, however, much silver chloride present, but in its association with this lode it differed from any other mine on the field. The limonite was penetrated by numberless small cavities, each of which was lined with a layer of the compact fibrous variety of this mineral, and in the cavities was a quantity of silver chloride of a bright yellow hard crystalline variety, quite unlike any other found outside of Broken Hill and resembling iodembolite, but its exact composition was never determined. Compared with the native silver, which was enclosed in lumps in the limonite, it was a more recent deposit. It had probably been derived from the leaching of the silver at higher levels. As the silver-bearing solutions found their way downwards through the cavities, they would encounter precipitating agents in the surrounding mineralised waters, which no doubt were responsible for the deposition of the chloride.

The effects of oxidation with consequent enrichment of lead sulphide are seen in nearly all galena lodes, with little variation in any of them. Silver chloride is found in places in the earthy crust of carbonate which is then of higher silver value than the original sulphide. This altered ore was of common occurrence in the Barrier mines and was known as "gray ore." It was an important mineral owing to the quantity in which it was found in the early days of the field. Its silver value was variable and dependent upon the class of ore from which it had been derived.

Potter's mine (Condobolin) contains an example of the medium grade variety of galena lode. Of normal type it consisted of lead sulphide with no other minerals above the water level, excepting that nearer the surface the sulphide had been changed to sulphate and carbonate with some enrichment of silver in the process of alteration. Solutions passing downwards through the lode apparently enriched the deeper bodies as they gradually brought about their oxidation. The silver values of the altered ores were therefore always higher than those remaining unchanged, though the difference in this case was not great. There was not sufficient silver to separate out as visible chloride as was seen in similar, but richer, ore bodies of the Barrier field.

All the changes of mineral character brought about in these lodes were effected *in situ*, and therefore there was a chemical change without redeposition. Invariably, as was the case in Potter's mine, when the water level was reached and the unaltered sulphides were entered, blende and often pyrite were present, a combination which denoted lower values and frequently brought the end of profitable mining operations in sight.

A better illustration of oxidation, without the formation of anglesite as a separate mineral, was seen in the Richard Ruby mine (Apollyon Valley). The lode consisted of lead ores forming what had been the largest body of solid, clean galena known in this part of the field. It was several feet in

Digitized by Google

thickness and near the surface had been changed on either side for a third of its width to " gray ore " (cerussite) of massive type, the division between the two ores being very sharp and distinct. The Writer is unable to recall the silver values, but the carbonate was much the richer.

Solutions which caused oxidation in these lodes therefore had an enriching effect; where they passed through bodies of rich silver ore they increased correspondingly the silver value of the underlying ores. It was due to this action that some deposits of bindheimite were of such high value; the richer the associated silver minerals the more highly impregnated were the deposits affected. This mineral was not known to occur with low grade sulphides. Probably it had been derived from the alteration of antimonial lead ores, but it was rarely, if ever, seen in mines in which there were no silver haloids with which it was more or less impregnated as a result of the leaching of the ores at higher levels.

The deposits of secondary minerals are generally patchy and are often confined to parts of an area which to all appearance is otherwise quite uniform. The surrounding conditions being the same might be expected to prevent such isolated effects, and it may be difficult to understand why any particular point is chosen for redeposition. Instances have been described already where chemical action has resulted in the alteration of minerals at certain points while others exactly similar in the immediate vicinity have escaped. Evidence is not wanting to show that the conditions which affect these changes may be recurrent, the intervening periods showing quite different results. Such changes are not always beyond explanation, they may be due either to a break or change of structure in the enclosing rock, or to an invasion of the localities by mineral solutions.

Underground waters may, and sometimes do, exist under pressure in a particular part of a lode, and thus be a cause of chemical action at that point or its vicinity. In the Consols mine a strong stream of water at a comparatively high level was unexpectedly tapped, and could not be wholly dammed back as its pressure was sufficient to force it through the rock. The pressure was not great (a few pounds per square inch), but it caused over 80 per cent. of the flow to pass round the dam and into the level in which it was built, a considerable distance from it. The rock was schist. The water continued for several years without abatement and is probably still flowing. This is not related as a very exceptional, or even unusual, occurrence; but it is apparent that such a stream of water directed upon an ore body would be capable of effecting some of the changes that have been described. It would decompose mineral matter and cause its removal from one point to another, a process that is in constant operation. Similar flows of water could be caused by earth movements resulting in the opening of small fissures in the rock at certain points, perhaps after the ore bodies had been deposited. That such movements occur is shown by the destruction of the large crystals of quartz in vughs, as referred to elsewhere in these notes, and more commonly by faulting of the lodes.

Digitized by Google

2. MINERALOGY OF THE AUSTRALIAN BROKEN HILL CONSOLS LODE.

As this lode is comparatively small and compact the effects of oxidising influences and replacements could be followed without difficulty.

The lode passes through bands of amphibolite into mica schist, but is ore-bearing only where it is enclosed by the former rock. Levels driven for hundreds of feet in the schist on either side of the amphibolite, and following the fissure, disclosed nothing but a thin seam of flucan. On each side of the amphibolite and contiguous to it is a metamorphic rock provisionally called tremolite schist owing to the presence of that mineral. This gradually merges into mica-schist from which it was, presumably, changed through contact with the amphibolite.

The principal gangue above the water level is limonite. Below this level, which is reached at a vertical depth of about 130 feet, siderite is the chief gangue, calcite with some quartz being present throughout. In the order of deposition the quartz was first formed as a thin layer on each wall, then siderite, with calcite in the centre. In places there are several alternate bands of these minerals, any open spaces being lined with crystals of calcite, limonite or quartz; many have been filled with galena. In the upper levels the calcite was partly removed by solutions which had penetrated into the cleavage planes and so caused a general disintegration. Many vughs in the limonite contained large pseudomorphs of that mineral after siderite, often with small deposits of manganese oxides. Similar vughs existed in the siderite and fine crystals of that mineral were met with, forming the roof. Masses of dyscrasite filling the openings had taken a perfect impression of these crystals, and in official publications these have been erroneously described as pseudomorphs after siderite.

In places the calcite had enclosed nodular masses of crystalline dyscrasite, which in the general oxidation of the lode had been changed into chloro-antimoniate of silver, a new compound which is described elsewhere in these notes. On the dissolution of the calcite containing them the nodules were left loose in the open spaces. In the shallower levels they had been further acted upon and so leached that they were practically reduced to patches of insoluble oxide of antimony held together by a later deposit of cerargyrite. Other masses less altered retained their original form and were encrusted with crystals of the silver chloride.

The limonite occurs from the surface almost to the water level, at which depth oxidation was less pronounced, its place being taken by siderite by a gradual transition. The gangue at all levels continues from one side of the amphibolite to the other, ending abruptly at the point of contact with the schist. The width of the ore-bearing ground therefore corresponds with that of the amphibolite. Ore is not found over the whole of this area, however, as has been explained elsewhere,* the deposits are confined to localities where certain conditions prevail; in other parts of the lode, although the gangue might be of the most favourable character, they do not occur.

The underlie of the lode generally is flat, and from about 300 feet downwards very irregular, being almost vertical in some parts and nearly vertical

* Smith, Trans. Am. Inst. Mg. Engrs., Vol. XXVI, 1896, pp. 69-78.

Digitized by Google

in others. It is remarkably well defined throughout and the most perfect of its kind. The ore is found most frequently in the steeper parts of the lode, which is not the general experience in similar mines.

The lode is generally believed to have been formed at a later period than the Broken Hill lode from which its mineral contents have been derived by some process of leaching. In 1897 a branch from the Proprietary mine containing unusually high silver values was followed some distance eastwards in the direction of the Consols, and was regarded as strong evidence of the supposed connection of the two lodes. Considering this theory from the Consols end there seemed to be nothing in its favour. The lode fissure was followed in the schist for hundreds of feet towards the Proprietary mine, and though well defined and undeviating in its course, it was found to be free from all mineralisation outside the amphibolite. It is inconceivable that solutions responsible for the conveyance of so much mineral matter could pass through a quarter-inch fissure for a great distance without leaving any trace of mineralisation on the way or effecting some alteration of the rock in its passage. It is much more probable that, whatever the source of the silver may have been, it was confined to the amphibolite which encloses the lode, and in which it is only known to be ore bearing.

Near the surface, besides galena, which formed separate deposits of little importance, the principal minerals were cerargyrite and silver chloroantimoniate, the former generally impregnating the limonite gangue, the latter in isolated bodies. Below but still within the oxidised zone, the largest deposits of silver minerals were found. These consisted of stromeyerite, dyscrasite, cerargyrite, and iodyrite, each in large quantity. Tetrahedrite was first seen in this zone as an associate of these ores, but it was not recognised in the very shallow levels although in greater depth it occurred in considerable quantity. None of these silver minerals, with the exception of dyscrasite and tetrahedrite, were found below the water level.

Lying between the completely oxidised zone and the definite sulphide zone, native silver in beautifully bright crystallised wire-like masses occurred in solid calcite. In one stope the largest deposit of the silver was found lying loose in a mass of sludge in an opening formed through the dissolution of the calcite in which it had been embedded. These deposits were in the vicinity of each other; in one case the calcite, through which the silver was distributed, was quite unaltered, in the other it had been removed. Chemical action had been concentrated upon one deposit, while others identically the same near by were not in any way affected. The dissolution of the calcite was a repetition of what had been seen in shallower levels, but there the ore was altered and perhaps removed; in the lower level the gangue had been destroyed, but the silver was not even tarnished. Even in large ore bodies the effects of concentrated chemical action may be seen at certain points, while around and in close proximity there may be no sign of it. Its result, are, however, constructive as well as destructive, as may be seen in the occurrence of isolated deposits of secondary minerals in localities to which they do not appear to belong. Lode solutions of the higher levels would be strengthened by the decomposition of sulphide ores, and might be expected to vary in their action at various depths; but in the lower levels the permanent mine water would have diluted the more acid type passing downwards.

Digitized by Google

The ordinary water of the mine is not too highly mineralised for garden purposes, though it was only the more hardy plants that could be cultivated with it. The mineral matter present is sulphate principally, but the exact composition cannot be recalled.

In the same zone pyrargyrite, proustite, and sternbergite were found, the last two being each confined to one deposit. Stephanite, another rare mineral, was met with at a somewhat lower level, also in limited quantity. Below this the only silver ores remaining, with the exception of films of pyrargyrite in the siderite, were dyscrasite and tetrahedrite. These continued to the lowest levels and are believed to be primary and permanent minerals. They were somewhat different from the varieties found above, the dyscrasite being in large crystals with coarser fracture and well-marked cleavage, denoting lower silver values, and the tetrahedrite rather darker in colour indicating (in this lode) rather less silver and more copper. The actual difference, however, was not great.

There seems little doubt that the occurrence in the upper sulphide zone of such minerals as pyrargyrite, proustite, stephanite, and sternbergite was due to secondary deposition from above. These minerals were not seen in the oxidised zone, and they did not extend far downwards in the sulphide zone. The films of pyrargyrite already referred to would appear to be an exception, but these also gave evidence of decreasing in quantity and finally ceasing to exist before much greater depth was attained. Pyrargyrite appeared to be an impregnating material in the lower levels as cerargyrite was in the levels above; but its impregnation of the gangue was never so complete and the quantity of silver involved was infinitely less.

As the deposits of secondary sulphides became smaller and fewer the enrichment of which they were a part gradually diminished. It continued downwards, however, in ever lessening quantity long after the area containing these definite mineral deposits had been passed. This gradual decline in values with increasing depth appears to be general. The Great Cobar lode might be instanced as an outside example to show consistent fall of values with depth, or, in other words, diminishing enrichment with increasing distance from the enriching zone.

It seems probable that the secondary silver ores of this mine were derived from the decomposition of dyscrasite, which was found from the upper to the lower levels in relatively great quantity for such a rare mineral. Upwards of 10 tons were obtained in an unaltered condition in addition to many tons which had been partly or completely converted into the chloro-antimoniate. There were also other bodies which had reached such a stage of decay that their silver content had been almost entirely removed, to be again deposited in other forms, perhaps in the immediate vicinity. An insoluble white or yellow oxide of antimony was sometimes the sole survivor of the original ore body and this remained incorporated in the masses of silver ores which had replaced the earlier forms.

On the assumption that the lode in its lowest levels had passed out of the amphibolite and had therefore lost its ore-bearing character, mining operations were suspended. A change of rock was, however, never known to destroy the continuity of this lode, and the absence of its fissure should have been sufficient to indicate that some other cause was responsible for such an unexpected development. The mine plans show that at a certain

Digitized by Google

point the lode had passed through the amphibolite, which is illustrated on the plans as a sort of volcanic pipe. The possibility of faulting of the amphibolite, and its continuance beyond the fault, did not appear to have been considered, and the plans were drawn to fit this theory, in support of which there is no evidence.

E. C. Andrew's maps which accompany his "Geology of the Broken Hill district" supply the explanation by showing clearly that through faulting, the lode and its enclosing rock have been considerably displaced, whilst beyond the fault the amphibolite continues as before. This is what might have been expected. A better illustration of the value and necessity of geological knowledge as applied to mining operations could hardly be given.

The original ore bodies are believed to have been derived from ascending solutions which were confined to the amphibolite, and would therefore have a deep-seated origin. There was never any reason to believe that these rich ores would not be found to continue downwards, though the secondary deposits of the shallower levels would remain the richest and the most extensive.

Those who know the mine could have no doubt of the permanency of the lode to whatever depth it may be followed. That it continues in the amphibolite beyond the fault, and possesses there the same ore-bearing characteristics as above, there is also not the slightest reason to doubt.

Digitized by Google

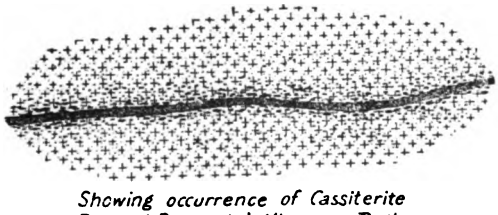
APPENDIX I.

THE OCCURRENCE OF CASSITERITE.

Geological considerations are beyond the scope of these notes, but as a means of broadening the description of this mineral it may not be out of place to refer to its mode of occurrence, as this has some bearing upon its mineralogical character.

The most frequent form of occurrence is due to the impregnation of granite, the ore filling crevices or joints and replacing the rock for some little distance on either side, or, perhaps on one side only, gradually becoming less as distance from the joint increases, finally being found in the form of fine grains. The total width may be only a few inches, or it may be several feet. Such deposits are seen at The Gulf in which the tinstone has replaced the granite on one side of the fissure, forming a solid body of ore which continues for a considerable distance. The ore in these deposits shows little crystallization unless there is a division in the centre, the opposite sides being then often covered with crystals facing each other. Where the opening has been wide enough to afford room for crystallization without meeting across the open space, perfect forms are generally met with. Where this condition did not exist the crystals have grown into each other and their forms are distorted or incomplete.

The following sketch is intended to illustrate a small, but typical, impregnation found in granite, near Tingha. In this deposit the joint is filled with tinstone with a maximum width of nearly an inch, the rock being impregnated also for a distance which varies from 6 to 9 inches on either side of the joint. Where the seam could be divided as was possible in some of the thickest portions, the rock on one, or both sides of the fissure, might be covered with crystals. In this occurrence the tinstone crystals were associated with small crystals of quartz containing rutile.



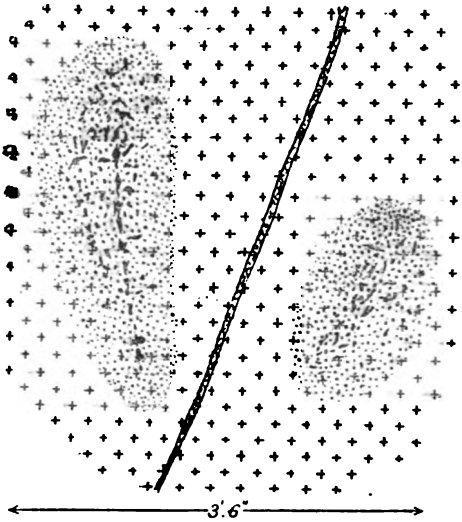
Showing occurrence of Cassiterite
Pat and Battersby's Mine, near Tingha
(13.10.20)

Fig. 2.

The next sketch shows a similar but more extensive deposit which, a short distance above the point illustrated, had yielded tinstone in much more solid form. The sketch represents the appearance of the ore as it showed in the face of a small underhand stope at 127 feet below the surface. The joint

Digitized by Google

was filled with quartz only, the tinstone being present in patches and specks some little distance from it. The tinstone was enclosed in felspar, the surrounding rock being aplite.



Showing occurrence of Cassiterite in Aplite
Elliot Mine, Cow Flat, Torrington
(20.3.24.)

Fig. 8.

Few of these impregnations are capable of yielding large quantities of ore, but the smaller ones are probably more numerous than is supposed as they may easily escape detection under the covering of alluvium. Tinstone in a fine state of division is being continually shed by them owing to the wearing down and disintegration of the granite, as may be seen all over the tin fields. In the township of Tingha after each heavy fall of rain little black streaks of fine tinstone and "black sand" (titaniferous iron) are found. The occurrences from which these are shed may be too small and scattered for ordinary mining development, but in the aggregate their disintegration must result in material addition to the concentrations in the watercourses and creeks.

Many of such impregnations have been exploited in various parts of the tin areas, but they have been found to be bunchy and uncertain. When the ore gives out they are generally deserted because they are so rarely large enough to merit systematic development.

The perfect crystallizations of Glen Eden are found in crevices in greisen, but are too scattered and erratic to be worth following. The Elsmore deposits are somewhat similar, but the joints are more plentiful and their contents more concentrated. The enclosing greisen is softer, and in consequence the ore is more readily shed; and as the bulk of it is loose, sluicing methods for its recovery may be used. In each occurrence practically the whole of the tinstone is crystallized, where the groups of sparkling crystals appear *in situ* projecting from their little vughy openings they are very handsome and interesting objects.

Digitized by Google

Among the smaller veins may be mentioned one near Tingha which has been followed for 33 feet, though it does not exceed about half an inch in width. Judging by surface indications it continues for a greater distance. It occupies a joint in the granite which on either side is composed of felspar forming a band about 3 inches thick, with a seam of tinstone in the middle and many specks of the same mineral on either side. This vein is notable as the most persistent and uniform of its type found in this locality. The enclosing rock is very hard, and owing to this and the fact that a strong inflow of water was met with in following the vein, work was not continued upon it.

In the same locality the granite surrounding a pipe formation may be seen enclosing a number of tiny, parallel, veinlets of tinstone. As many as twenty-five of these were counted by the Writer in the width of an inch.

The following sketch represents a section of a small tinstone vein found in the granite at Stannum, but the Writer did not see it *in situ* :—

Section of vein showing alternate bands of Cassiterite and Quartz Cooks vein, Stannum

Fig. 4.

There were four veins of solid tinstone and five of white milky quartz; the alternate bands were remarkably regular and uniform in size. The total thickness of the vein was about 2 inches.

An unusual occurrence at Newstead consists of large masses of siliceous rock, resembling quartzite, through which the tinstone is distributed in isolated rounded fragments much like abraded, lustreless crystals. This rock was examined by G. W. Card, who stated that, "It certainly is not a quartzite, nor is it considered a normal igneous rock. It looks more like a deposition of silica from solution in the last stages of eruption. It contains topaz."

The pipe formations do not contain the fine crystallizations of the other deposits, but they present many interesting features. They appear to be persistent in their downward extension, and many have been abandoned though good ore was continuing underfoot. The procedure in mining is to follow them downwards, and, when they are small, as they often are, to excavate only sufficient rock to give working space. Operations then soon become cramped, and as the pipes are always irregular, the first strong inflow of water generally brings operations to a close. They are rarely large enough to warrant the installation of pumping appliances.

Digitized by Google

The following sketches show a formation of this type, though in this case there are several branches instead of the usual single pipe:—

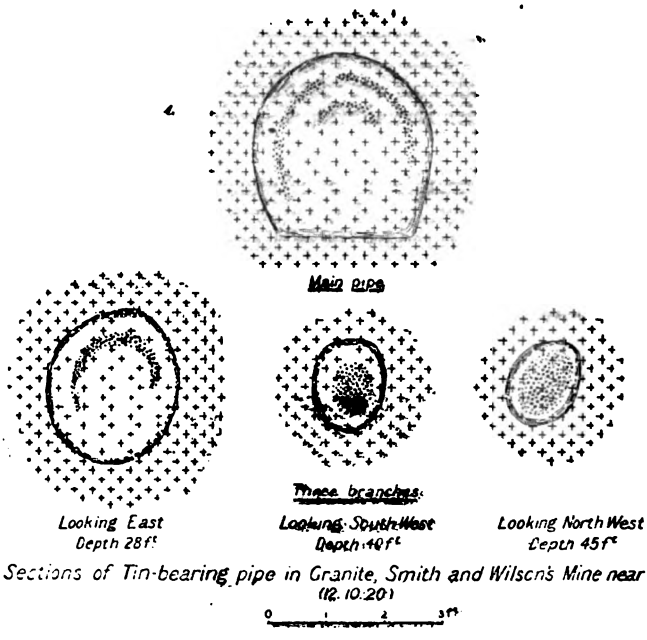


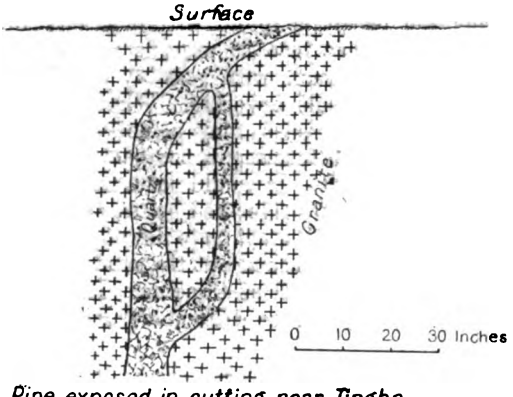
Fig. 5.

The branches are all connected with a main pipe and the sketches represent them as they appeared on the same day in a small mine near Tingha. Below where the branches were seen, the pipe consisted of a single channel which had been excavated and so could be entered. It was found to be very much larger than the branches, being about 3 feet 6 inches in diameter and nearly horizontal for some distance. It presented a very symmetrical, slightly oval, funnel-like opening with smooth walls, showing that it had been separate from the enclosing granite. In following it upwards from the "funnel" it was found that whenever a sharp turn or bend occurred in the main pipe a branch had been thrown off which continued in the direction the pipe was taking at the time. The top section illustrates the main pipe as it appeared in the roof of the stope at a vertical depth of 15 feet. Around and within the outside rim is a silicified band 4 inches wide. As will be seen the quantity of tin-stone, which at these higher levels occurred as small specks, is limited. In each section the rock is granite similar to that seen outside, but it is somewhat altered and rather softer.

The following is a sketch of the vertical section of a small pipe in the same locality which is low grade and not large enough to be of payable value.

Digitized by Google

It is composed of siliceous material containing specks of tinstone sparsely distributed through it. The enclosing rock is granite.

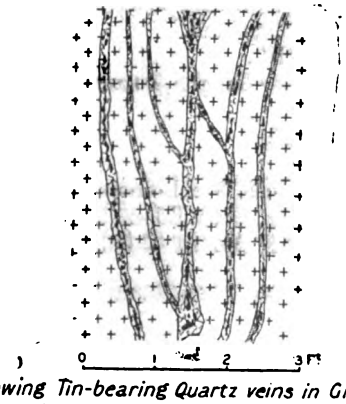


Pipe exposed in cutting near Tingha.
(14.5.24)

Fig. 6.

The lodes have not produced any interesting tin minerals during the past twenty years, though some of their associates, quartz and fluorite, are notable in the shallower levels. Crystals of tinstone are to be seen where the ore body is vughy, but they are very small. In the quartz veins of the Watson's Creek (Bendemeer) and Mount Tallabong (Condobolin) type the tinstone occurs in amorphous patches with no crystallization or other interesting features of any kind. The finer crystals appear to be confined principally to the smaller deposits, unimportant individually, but collectively capable of producing large quantities, as at Elsmore.

A small occurrence of the stockwork type at The Oaks (Tingha) is shown in the next sketch. The veins are quartz with tinstone distributed through them in small amorphous fragments. The enclosing rock is granite. Possibly there are other veins which, however, were not exposed in the small stope illustrated.



Showing Tin-bearing Quartz veins in Granite
Kennedy and Woolley's Mine, near Tingha
(1.3.24)

Fig. 7.

Digitized by Google

There are several depositions of alluvial tinstone under and between flows of basalt, and surface concentrations. The ore differs in the various districts as explained elsewhere. The depth of the wash varies greatly. In some deep alluvial leads the basalt is found within a very few inches of the bedrock, which has to be cut into to provide working space. In others there may be several feet of wash, with possibly 60 or 70 feet of drift and clay between it and the basalt covering. What appears to be a later deposition of tinstone in the wash may sometimes be seen 2 or 3 feet above the bottom of the lead forming a compact layer of ore, perhaps 2 inches thick, in the sandy drift. It would seem that the sand had become somewhat consolidated in the old river bed before the later deposit was laid down, otherwise the water, which must have flowed with some force to carry the tinstone along, would have washed out the sand it rests upon. A somewhat similar occurrence was noted at Copeton. In this deposit diamonds are associated with layers of coarse drift some distance from the bottom wash.

The following minerals have been found associated with cassiterite in ore-bodies :—

Azurite.—Gumble (Manildra).
Actinolite.—Howell.
Beryl.—Emmaville, The Gulf.
Bismuth Native.—Kingsgate.
Bismuthinite.—Kingsgate.
Blende.—Torrington, Tent Hill.
Bornite.—Tingha.
Cairngorm.—The Gulf.
Chalcopyrite.—Tent Hill.
*Chlorite.—Torrington, The Gulf.
Emerald.—Emmaville.
*Fluorite.—Torrington.
Galena.—Torrington, Tent Hill.
*Mispickel.—The Gulf, Tent Hill.
Molybdenite.—Kingsgate.
Monazite.—Terrington.
Muscovite (crystallized).—Dundee.
*Pyrite.—The Gulf, Tent Hill.
*Pyrrhotite.—Tent Hill.
*Quartz (crystallized).—Tingha, Torrington, and many other localities.
*Rutile.—Tingha.
Scorodite.—Tent Hill.
Topaz.—Emmaville.
Tourmaline.—The Gulf, Ben Lomond.
*Wolfram.—Kingsgate, Glen Eden, Torrington, The Gulf, Elsmore, Wilson's Downfall, Mount Tallabong.

The following minerals have been found associated with cassiterite in alluvial deposits :—

*Bismite.—Elsmore.
*Bismutite.—Elsmore.
Beryl.—Torrington, The Gulf.
*Diamond.—Copeton, Tingha, Howell.

* Indicates those minerals which occur most commonly or in notable quantities.

Digitized by Google

*Garnet.—Copeton.
Gold.—Tingha, Marulan.
*Jasper.—Tingha, Copeton.
*Limonite (pisolitic).—Tingha.
Magnesite.—Tingha.
*Magnetite (pisolitic).—Tingha.
*Monazite.—Elsmore.
Orthoclase (crystallized).—Tingha.
*Pleonaste.—Copeton.
*Rutile.—Tingha.
*Sapphire.—Tingha, Copeton, Elsmore (deep lead), and many other localities.
Scheelite.—Skeleton Creek (Glen Innes).
*Titanic Iron.—Tingha, Copeton.
*Topaz.—Tingha, Copeton, Torrington.
Tourmaline.—Copeton.
*Wolfram.—Glen Eden, Torrington. The Gulf.
*Zircon.—Copeton, Tingha, Elsmore (deep lead), Bald Nob, and elsewhere.

* Indicates those minerals which occur most commonly, or in notable quantities.

Digitized by Google

APPENDIX II.

THE OCCURRENCE OF MOLYBDENITE.

The largest proportion of the output of molybdenite of New South Wales is obtained from quartz pipes in granite, and the most perfect examples of this class of deposit are found at Kingsgate, where they form a standard by which the deposits of other localities may be judged. There are many molybdenite occurrences in the Kingsgate district, which are arranged parallel to the junction of slate and granite, the largest pipes being nearest the contact. As many as fifty or sixty deposits have been found within an area of about 2½ miles by ½ mile. All occur in granite; one is said to have been connected with the slate, but on being followed to that rock it was found to pass back into the granite.

Many of the pipes have been worked extensively, and though they have proved to be characteristically bunchy and uncertain, they have been found to be productive to the deepest levels to which they have been followed. This does not necessarily imply that ore still shows in the bottom of the shafts when suspending operations; it is not customary to leave ore which can be profitably extracted in any mine; but it indicates that other bunches of ore will be found when explorations are resumed, providing the pipe is of a favourable character and is followed in the proper direction. So far as yet proved the mineral does not decrease in quantity or quality as it is followed downwards, although there are richer and poorer areas. It may be stated, however, that though the workings may extend for several hundred feet along the course of the pipes, the vertical depth may yet be comparatively shallow.

The quartz which forms the pipes is of two kinds, one a colourless to milky-white and the other a gray to light brown, slightly friable, variety. In this district the ore is generally found in the latter, though it may rarely be seen in the former, and is most frequently confined to the footwall side of the pipe near the enclosing rock. If the ore does not occur on the footwall side it will be found on either side rather than near the hanging-wall. This rule can, however, only be rather loosely applied to occurrences which change their inclination so frequently and so suddenly. When such changes of direction occur the deposits are found in many places on the outside of a turn or bend.

Large and perfect crystals of quartz were common at one time, and the vughy nature of the formation of which these crystals were a part was regarded as a favourable indication of the proximity of ore, or as indicating the track to be followed in searching for it. In prospecting the large pipes a shaft can only prove one portion, and so it is always possible to pass on one side of the ore. There are, however, certain indications, such as vughy ground, which is generally lined with quartz crystals, or characteristics in the quartz itself which may suggest the direction in which the ore should be looked for. The ore, again, may have passed from the quartz into the granite, as it often does with every sign of permanency; but it does not follow that, in such an event, the track of the ore would show the permanent direction of the pipe; on the contrary, it would indicate the reverse. In no instance has a false lead of this kind led to anything but disappointment, as the ore does not continue far into the granite however favourable it may appear to be for some distance.

Digitized by Google

The pipes are most irregular, rarely pursuing a direct course for any distance; many change their inclination from the vertical to the horizontal, and perhaps turn again at sharp angles within a short distance. They may branch off in a downward or upward direction from the main pipe, and it may be impossible at the time to determine correctly which is the proper branch to follow. The wrong one is frequently chosen, and when this has been proved, operations must necessarily be transferred to another. The main pipe is thus eventually found and it generally opens out again with its original characteristics. This irregularity increases the cost of mining and as depth is attained and water becomes troublesome, the ore needs to become more plentiful than it generally is to cover those costs, for by this time the crookedness of the shaft will have increased the difficulty of raising the waste material. In such cases, where these difficulties had become serious, attempts have been made to prospect from vertical shafts, a very desirable method if it could be adopted, but in no case has the Writer known a deposit to be found by crosscutting from a vertical shaft in new ground.

Many roughly circular or oval pipes of the Kingsgate type are found in other localities, but there are others which are more vein-like in form and yet distinct from ordinary veins. These, as developments have proved in several cases, are also pipe formations, though they bear so little resemblance to those of Kingsgate. The Allies and Cooper's deposits in the Deepwater district are of this class. Near the surface they possess the form of short veins or rock joints containing little or no ore and apparently of little promise. They then presented no indication of the great developments that deeper exploration was to show. Both pipes were very flat near the surface, and it was not until they had been followed for a considerable distance that these splendid ore bodies began to show their capabilities by yielding an abundance of mineral that was probably never equalled in the palmy days of Kingsgate; and yet no two rich bodies of this mineral showed a greater diversity in the form of the deposits. It seems remarkable that they should have developed so splendidly from such little beginnings, while the more imposing quartz pipes in the same district which appeared so full of promise were to prove failures.

As the workings of the Allies mine were extended downwards the pipe proved to be very vughy, and the vughs were elongated, each being occupied by molybdenite and quartz crystals forming vein-like branches extending from one side of the pipe to the other, over a very unusual distance. In the Manbundi mine adjoining, the pipe, or a portion of it, has been intersected at a vertical depth of slightly more than 100 feet. In this mine the ore does not possess the crystallization which characterises the Allies deposit. This might be accounted for by the absence of the vughs and the fact that contact has been made with the "trap," though the ore does not enter that rock but continues as a vein at its junction with the granite.

While the Allies was at its best, Cooper's mine was developing phenomenally. From a mere rock joint containing traces of ore near the surface, it was found to open out into a solid pipe-like body, probably the most compact and largest single mass of this ore seen in the State. Unlike the Allies deposit, which is some miles distant, it was practically without crystallization either of quartz or molybdenite. The pipe was composed almost entirely of solid ore forming a more or less round core surrounded by granite. Thus it was comparatively small but concentrated, the opposite to the Allies bodies, which were extended over a large area and were never compact.

Digitized by Google

E. C. Andrews* describes a mass of molybdenite in Sach's mine (Kingsgate), exceeding a ton in weight. The Writer never saw such a large single detached mass, but if the ore body as it was exposed in Cooper's mine could be compared with it, the Kingsgate weight would be greatly exceeded. The ore was pure, one of the shipments is said to have been the richest produced in Australia, being slightly higher in assay value than the richest parcel dispatched from the Queensland mines, which up to that time had held the record. The shipment weighed 3½ tons and contained 97·6 per cent. MoS_2. Other parcels were of practically the same high grade.

There are in other districts pipes consisting of the white milky variety of quartz which, at Kingsgate, would be considered an unfavourable matrix for molybdenite, but which have been found to be highly mineralized. The largest and richest deposits at Kingsgate are associated with large quartz crystals which are regarded as a desirable, almost an essential, association of such deposits; but the most plentifully furnished of this class in the Deep-water district is practically barren, so it is evident that each district should be judged by its own characteristics. A pipe formation to be rich need not necessarily be composed of quartz in the Kingsgate sense; Cooper's mine shows that, even where it was richest, it could not have been considered a typical quartz pipe, though its other characteristics are apparently identical. The ore was known to strike off into the granite, as it is commonly observed to do in quartz pipes of ordinary type, and it was just as evident that it would not continue in this rock, though it might be profitable to follow it for some distance. In the end it is always advisable to return to the main pipe where it is known to be entire, and whence it may be traced. Each field possesses its own problems; but there is a strong resemblance between them all, so that the experience gained upon some may be usefully applied in overcoming difficulties presented by others. As bearing upon this subject the difficulty of determining the downward extension of the pipe in Block 45 (Kingsgate) might be referred to. The continuation of this, one of the largest and richest of the molybdenite deposits in the State, after being followed downwards for a considerable distance was seen to be interrupted. Near the bottom of the shaft a small quartz pipe was found which continued downwards almost vertically and was followed for a further 100 ft. or more. Molybdenite continued in this, but it did not correspond with the larger pipe from which it was supposed to continue. An unsuccessful attempt was made to discover other branches, and as none were found this narrow contracted pipe was accepted as being the continuation of the main body. If there is reason to believe the continuation of the main pipe has been lost, there seems but one remedy, which is to return to the position above which is known to have been complete, and ascertain from that point where the change occurred and what it portends. Consequent operations would depend upon the result of such investigations; it is unsafe to assume anything, and therefore it is wiser to prove the ground already passed through completely before embarking upon enterprises in new ground.

The only true vein deposit which appears to possess any of the elements of a successful mine may be seen at Moonbi, where a quartz vein outcrops for about three-quarters of a mile. Molybdenite shows at various points, and where the vein has been opened some good bunches of ore associated with chalcopyrite and other minerals have been obtained. Very little work however was done on the vein, which is from 9 to 12 inches wide, and

* "The Molybdenum Industry in N.S.W.," Mineral Resources, No. 24, 1916, p. 96.

Digitized by Google

its chief interest lies in the fact that it seems to be the only representative of its class in the Northern district to show any promise of developing satisfactorily.

Many other quartz veins may be seen which vary in type from those at Mount Barney (Newton Boyd), whose principal value may be found in their bismuth contents, to those which occur in a parallel series, very small and comparatively rich, but always unpayable because of their size and the hardness of the enclosing rock.

A third class of deposit is represented by permeations of molybdenite as specks or small flakes in granite. These rarely exceed an inch in diameter and are not continuous. They may be sparsely distributed over a large area, but not sufficiently concentrated at any one point to yield ore in payable quantity, and they appear to lack permanence. The Boorolong (Armidale) deposit is an example of this type; the ore showed on the surface over an area so wide that it is by far the largest of its kind in New England, but when it was opened to a very slight extent the ore failed. The only associated mineral is bismuthinite in infinitesimal quantity. There are many similar, but much smaller, occurrences which, being contained in hard granite, have not been developed beyond the elementary prospecting stage, which is however sufficient to show that in some at least the ore is not continuous.

In only one instance was molybdenite known to occur in "trap." This may be seen in Edwards' mine (Deepwater) in which the ore passes out of the granite and continues for some distance in this rock. It does not extend far beyond the junction of the two rocks, however.

The following minerals have been found associated with molybdenite:—

* Bismite.—Kingsgate, Deepwater.
* Bismuth (Native).—Kingsgate, Deepwater.
* Bismuthinite.—Kingsgate, Deepwater.
· Bismutite.—Kingsgate, Deepwater.
Blende (Marmatite).—Deepwater.
Cairngorm.—Kingsgate.
Calcite.—Deepwater.
Cassiterite.—Kingsgate.
Chalcopyrite.—Goodrich (Yeoval), Moonbi.
* Cosalite (varieties).—Kingsgate, Deepwater.
* Garnet.—Whipstick.
Joseite.— } Whipstick.
Bismuth Telluride.— } Kingsgate, Deepwater, Bismuth.
* Kaolin.—Deepwater.
Magnetite.—Dundee.
* Mica —Kingsgate.
* Molybdite.—Kingsgate, Deepwater, Glen Eden, Bald Nob, Wunglebong, Wilson's Downfall, Whipstick, and elsewhere of less importance.
* Pyrite.—Kingsgate.
* Pyrrhotite.—Kingsgate.
Tungstic-trioxide.—Kingsgate.
* Wolfram.—Kingsgate, Glen Eden, Dundee, Wunglebong.

* Indicates those minerals which occur most commonly, or in notable quantities.

Digitized by Google

APPENDIX III.

THE OCCURRENCE OF WOLFRAMITE.

The ratio of FeO and MnO to WO_3 varies to such an extent that it is difficult to decide when a mineral should be classed as wolframite, the iron-manganese tungstate, or ferberite, the iron tungstate containing some manganese oxide. Assuming that they should be divided according to the preponderance of MnO over FeO, or *vice versa*, it then appears that wolframite, which contains a larger percentage of manganese than iron, has only been identified as occurring in one part of this State, and the tungsten mineral so plentifully distributed should be classified as ferberite.

The Writer's experience of recent years has been confined to the northern part of New South Wales, so he will refer more particularly to deposits in that part of the State where, as it happens, the most important occurrences of wolframite are found. His acquaintance with those of other districts was pre-war, and therefore before the great demand for tungsten ores led to their development.

As showing the variation in composition between wolframite and ferberite the following analyses of these minerals by H. P. White are given. The first two are regarded as ferberite, the third as wolframite:—

	Bismuth Mine (Torrington.)	Rockvale Mine (Tungsten).	Restdown Mine Yalgogrin.
WO_3	70·73	74·90	62·79
FeO	18·13	20·44	5·39
MnO	3·64	3·28	14·46
CaO	1·64	·48	.....
Gangue	5·55	·52	17·09
H_2O	.....	·26	·13
	99·69	99·88	99·86

Tin, tantalum and rare earths were absent in each case.

The varieties which, owing to their high FeO content, are classified above as ferberite, closely resemble in composition some that are referred to by Dana* as wolframite. Where isomorphous mixtures occur in such variable proportions it is difficult to draw a line of division between what are really variations of the same mineral.

For convenience, and because the old title through common usage is so much better known, the name of wolfram will be adopted in these notes in general reference to the manganese-iron tungstate, though it might more accurately be described in most, if not in all, cases as ferberite.

By far the largest output has been derived from a rock locally known as "quartzite," but which G. W. Card has determined as topaz-greisen. The ore is disseminated through it in fine particles with an occasional rich bunch, in which there may be large masses of clean ore. These deposits are sometimes connected with quartz veins, or with veins of pegmatite of a type that is frequently associated with the mineral deposits of the district. Adjoining the greisen is a dark-coloured compact rock known through the northern district as "trap," which has also been examined by Mr. Card

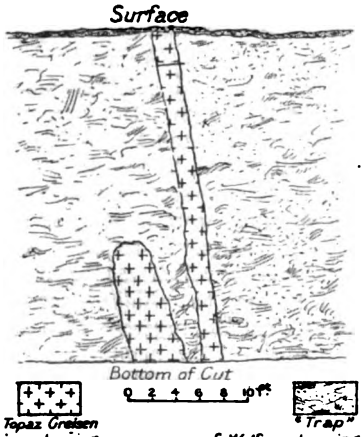
* A System of Mineralogy, 1888, pp. 602-603.

Digitized by Google

and described by him as an altered sedimentary rock. Since his determination it has been found in the Wild Kate mine to contain water-worn pebbles.

The greisen is extensive; it must cover many acres. Some thousands of tons have been treated, but except where the richer bunches of wolfram occur it is of very low grade. The Block 14 mine (Torrington), the largest producer of tungsten ores in the State, before its close was treating stone averaging ·5 to 1 per cent. WO_3. At the Rockvale mine, 3 miles distant, and almost as extensive, the grade was ·6 per cent. In each case a small recoverable amount of bismuth in the form of oxide was present.

The following sketch represents the end view of an open cut in the Rockvale mine. It is not intended to illustrate an unusual combination of the rocks, though as a rule the cuts were entirely in the greisen. No ore was found in the "trap."



Section showing occurrence of Wolfram bearing Topaz Greisen, Rockvale Mine, Tungsten, Torrington Dist.
(27 1.16.)

Fig. 8.

Many outlying masses of greisen have been tested at different periods by means of shafts, which in every case passed through the greisen and entered "trap" at comparatively shallow depth, the deepest less than 100 feet. That the greisen was proved not to continue downwards at any of these points tested is evidence of its great irregularity. In all of these occurrences wolfram exists in quantities generally exceeding the average value of the large mines already referred to, but in the absence of concentrating machinery it was impossible to deal with the comparatively low grade material met with. There still remain many masses of this rock as yet wholly, or almost, untested. Judging from the work done upon them by the companies and the results recorded, they show a gradual decline in value, either actual or recoverable, in depth. This lessening of value is, however, no doubt due in large measure to the fact that as the workings were extended laterally they reached beyond the limits of the most concentrated areas upon which operations were originally commenced.

Other deposits are contained in formations somewhat vein-like in their horizontal extension, but which do not show the fissure of true veins. They are probably altered pegmatites of which the felspar and, to some extent, the mica, have been decomposed, the ore in them being in concentrated pipe-like masses, locally known as "bungs." The inflow of water as the ore is followed downwards has an important bearing upon the mining of deposits

Digitized by Google

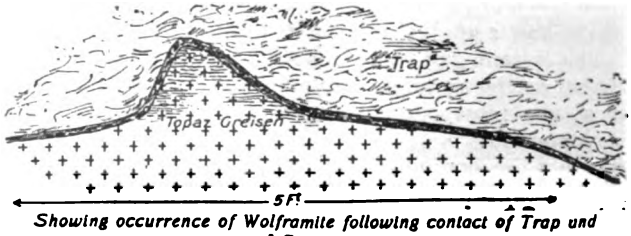
of this kind. Being always irregular in their downward course it is difficult to overcome the water without the aid of machinery, and in many deposits the occurrence of the ore is too limited, uncertain, and erratic to justify its installation. They are also found to decrease in value with depth, but whether further enriched zones may be met with in deeper levels has yet to be proved. Rumsby's pipe at The Gulf (Emmaville), which proved to be one of the largest and richest of the "bung" type, passed into a zone which contains very little wolfram, but the pipe at considerably over 100 feet in depth contains cuprite, native copper and chalcopyrite, with mispickel, though not in quantity sufficient to be payable. This, however, was an exceptional occurrence; in most of the other mines, as the ore became smaller or cut out, operations ceased as there was then little or no mineralization to encourage further prospecting under more costly conditions.

In these deposits of the "bung" type, the wolfram may be found detached from the containing rock. Large masses of ore were met with, some blocks weighing several hundredweights. In Donoghue's mine at Dingo Creek (Torrington), which was one of the rich productive deposits of this kind, the ore was followed in an underhand stope. In places one's arm could be thrust downwards through the water and mud to the loose angular masses of ore which might be felt while still *in situ*, but could not be seen.

The largest of the ore-bearing pegmatites was in the Bismuth mine (Torrington), whose original workings were in a mass of greisen similar to the other large occurrences in the district. In later years the development of the wolfram led on to the pegmatite which was found to contain so much native bismuth that this mineral became the chief objective in mining. With the bismuth were quantities of smaltite, together with much coarse black lithia-bearing biotite forming portion of the pegmatite. As representative of its class it was commercially the most valuable ore-bearing dyke on the field.

There are many smaller occurrences of this kind. That which contained the fine deposit of beryls in Heffernan's mine is one of them, but in that case the whole formation was exposed in less than the width of an underground level, with its mineral-bearing characteristics fully revealed. In all of them the ore is bunchy and uncertain.

The ore bodies are sometimes in that part of the greisen which lies very close to the "trap," but it is seldom that they occur at the contact. In one small mine, however, 3 miles west of The Gulf, the wolfram had left the granite, and at a depth of 40 feet passed into the "trap," in which it continued for some distance a few feet in from the junction. The wolfram occurred in small patches, similar to what is shown in the following sketch, but in this case, as will be seen, the ore followed the junction. It was the only occurrence of the kind known to the Writer. The shading of the apex of the greisen represents partial alteration.



Showing occurrence of Wolframite following contact of Trap and Greisen
Wild Kate Mine, Torrington
(8.9.19.)
Fig. 9.

Digitized by Google

It is rather unusual to find tinstone and wolfram in association in appreciable quantity. The two minerals are present in the New Hope and Butler mines (Torrington), and at The Gulf they are seen together, but the quantities are never large. The association is also met with in limited quantity in other localities.

Several of the Kingsgate pipes contain wolfram, molybdenite and bismuth ores, and the same minerals occur at Wunglebong (Tenterfield) and Dundee. Quantities of molybdenite and wolfram are associated in the same pipe at Glen Eden (Glen Innes). The quartz pipes of these latter localities are of the milky-white variety, and in that respect they differ from those of Kingsgate. The wolfram is irregularly distributed through the quartz and is less concentrated at certain parts of the pipes than molybdenite.

A notable association at The Gulf consists of large bunches of clear green fluorite, which is found in several parts of that field. Rumsby's wolfram pipe was the most important of these occurrences. In this pipe the fluorite was present in considerable quantity intimately associated with wolfram, most plentiful where it was largest and coming to an end simultaneously with it.

No wolfram deposits have been seen corresponding with the cylindrical tin formations of Tingha. Any resemblances of this class are not known to possess the compactness of the tin pipes, nor do they show the perfect funnel-like channels of that field.

E. C. Andrews,† discussing the question of maintenance of values in depth, in referring to certain Cow Flat (Torrington) deposits, doubts whether, as wolfram is probably amenable to secondary concentration, the highest values may not be expected within the upper 200 feet. There appears to be no evidence of secondary enrichment, but the yield of ore commences to decline well within that distance. It is possible that, as with molybdenite, there are richer and poorer areas, and improvement might be found by deeper exploration. Developments, however, up to the present, seem to show that there is a gradual lessening in quantity, and this is particularly the case in the "bung" deposits, as is shown by the less frequent occurrence of solid masses of ore. In all of these the large bunches are not far from the surface, but, as already stated, as they become impoverished, work upon them generally ceases, and therefore the possibilities of deeper exploration are never determined.

Wolfram is found with tinstone in the alluvium at Torrington, but, like scheelite of similar occurrence, the quantity is insufficient to be of commercial importance.

The following minerals have been found associated with wolfram :—

Anatase.—Torrington.
*Beryl.—Torrington, The Gulf, Wunglebong.
*Biotite.—Torrington, The Gulf.
Bismite.—Torrington, The Gulf.
*Bismuth (Native).—Kingsgate, Torrington, Dundee, The Gulf, Wunglebong.
Bismuthinite.—Kingsgate, Wunglebong.
Cairngorm.—Torrington.

* Indicates those minerals which occur most commonly, or in notable quantities.
† Rec. Geol. Survey N.S.W., 1907, Vol. VIII, Pt. 3, pp. 250–251.

Digitized by Google

*Cassiterite.—Kingsgate, Torrington, Glen Eden, The Gulf, Elsmore, Wilson's Downfall, Mount Tallebong.
Chalcopyrite.—The Gulf.
Copper (Native).—The Gulf.
Cuprite.—The Gulf.
*Fluorite.—The Gulf, Torrington.
Galena.—Torrington.
Mispickel.—The Gulf.
*Molybdenite.—Kingsgate, Glen Eden, Dundee, Wunglebong.
Monazite.—Torrington, The Gulf.
Muscovite.—Torrington.
*Orthoclase (crystallised).—Torrington, Kootingal.
*Pyrite.—Kingsgate.
*Pyrrhotite.—Kingsgate.
*Quartz (crystallized).—Kingsgate, Torrington, The Gulf.
*Smaltite.—Torrington.
*Topaz.—Torrington.
Tourmaline.—Emmaville.
Tungstic oxide.—Torrington, Kingsgate.

* Indicates those minerals which occur most commonly, or in notable quantities.

Digitized by Google

APPENDIX IV.

MINES OF THE BARRIER RANGES.

1888–1890 (inclusive).

Broken Hill lode—
- Proprietary.
- Block 10.
- Block 14.
- Central.
- British.
- South.
- Junction.
- South Extended.
- Junction North.
- North.

North-East of Broken Hill—
- Bonanza.
- Victoria Cross.
- Silver Crescent.
- Imperial.
- Cosgrove's.
- Potosi.
- Rupee.
- Round Hill.
- Consolidated.
- Globe.
- Star.
- Carbonate Ridge.
- Virginia.
- Piesse's Nob.
- Alpha.
- Eaglehawk.
- Argus.
- Silver Ring.

South-West of Broken Hill—
- Rising Sun.
- White Lead.
- Wheal Angus.

East of Broken Hill—
- A.B.H. Consols.
- East Consols.

Rockwell Paddock—
- Melbourne Rockwell.
- Sydney Rockwell.
- Maiden Rockwell.
- *Redhill.

Broken Hill–Silverton—
- †Red Flag.
- Centennial.
- O.K.
- Kaiser.
- Second to None.
- Nine Mile.
- Parnell.
- Southern Cross.
- †Invincible.
- Acacia.

Silverton–Thackaringa—
- Silverton Proprietary.
- Black Bird.
- Silver Crest.
- †Tom Cue's.
- Lily.
- Bonanza.
- Comstock.
- Thackaringa.
- Pioneer.
- Gipsy Girl.
- Gipsy Boy.
- Gipsy Queen.
- Homeward Bound.
- Lady Brassey.
- Outward Bound.
- Himalaya.

Umberumberka—
- Umberumberka.
- †Umberumberka East.
- Little Boz.

Pinnacles district—
- Pinnacles.
- Pinnacles Consols.
- Lady Bevys.

Day Dream district—
- Day Dream.
- Hen and Chickens.
- Red Lion.
- Jupiter.
- Tasmania.
- Germania.
- Barrier Chief.

* Asbestos. † Copper.

Digitized by Google

APPENDIX IV—*continued.*

Day Dream-Apollyon Valley district-
- Patience.
- Bobbie Burns.
- Gem.
- Gemini.
- New Year.
- Leo.
- Elsie May.
- A.1.
- Apollyon.
- Richard Ruby.
- Tom Thumb.
- Cleopatra.
- Imperial.
- Mascotte.
- Lady Carrington.
- Norwood Lads.
- Terrible Dick.
- Tower Hill.
- King Gunnia.

Purnamoota-Mt. Gipps district—
- Lone Star.
- Atlas.
- War Dance.
- War Dance Extended.
- Ethel.
- Bird in Hand.
- Alabama.
- One Tree.
- Lubra.
- Uncle Tom.
- Ballarat.
- Christmas.
- Treasure.

Purnamoota-Mt. Gipps district—*continued*—
- Yancowinna.
- Triumph.
- Kohinoor.
- Lost and Found.
- Brilliant.
- Victoria.
- Victory.
- Model Republic.
- Rise and Shine.
- Hibernian.
- Silverdale.
- Silverdale Extended.
- Nevada.
- Maybell.
- Maybell North.
- Kate.
- Manola.
- Britannia and Scotia.

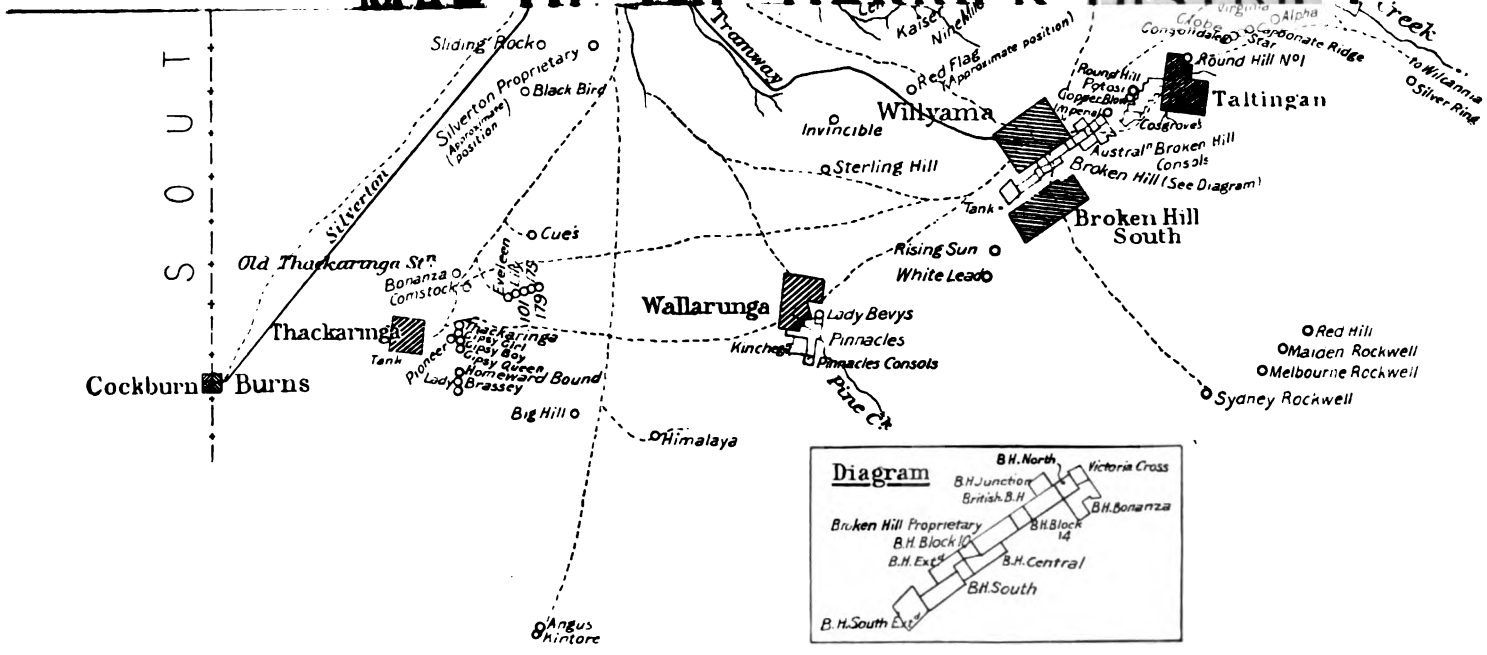
Purnamoota, North of—
- Eclipse.
- Great Northern.
- Black Prince.
- Mayflower
- ‡Silver King.
- ‡Golden Crest.
- Great Northern Proprietary.
- Jubilee.
- Australasian.
- Reidy's Blow.
- †Paragon.
- §Waukaroo Proprietary.

‡ Gold. § Tinstone.

Digitized by Google

To face page 138.

MAP OF THE BARRIER DISTRICT



68101

Digitized by Google

Speargrass ..... 69, 112 | ,, analysis of .....
† 68101—F

Digitized by Google

INDEX.

Page.

A.B.H. Consols lode, Mineralogy of the 117
Actinolite 62, 71
,, endomorph 58, 59, 62
Agate 59
Almandine 68, 112
,, analyses of 68, 112
Alunite 89
Amethyst 59
Amphibolite 117, 118, 119, 120
Analcite 62, 71
Analyses—
Almandine 68, 112
Anglesite 109
Argentite (replacing galena) 17
Automolite 49
Barytocelestite 91
Beryl 64
Bindheimite 80
Biotite 66
Boleite 38
Bournonite 33
Breunerite 101
Chenevexite 80
Chloro-antimoniate of silver 24
Chloropal 66
Chrysocolla 67
Conradite 45
Cosalite 33
Dolomite 101
Ferberite 85, 132
Gahnite 49
Galenobismutite 33, 34
Garnet Sandstone 69
Grossularite 68
Halotrichite 92
Joseite 26
Lead—carbo-sulphate 91
Lime-zinc carbonate 98
Lollingite 26
Marmatite 18
Molybdite 86
Monazite 82
Montanite 93
Nantokite 42
Orthoclase 72
Ouvarovite 70
Polybasite 34
Pseudophite 73
Pyromorphite 83
Raspite 87
Rhodonite 73
Rœpperite 74
Rutile 61
Silver chloro-antimoniate 24
Silver-lead-antimony sulphide ... 115
Smaltite 30, 31
Spessartite 69, 112

Page.

Analyses—*continued.*
Stilbite (?) 75
Stilpnomelane 75
Tetradymite 32
Tetrahedrite 37
Willyamite 32
Wolframite 132
Wollastonite 78
Zinc-lime carbonate 98
Anatase 43
Anderson, Dr. C. 23, 43, 64, 73, 94, 97, 100
Andrews, E. C. 49, 51, 119, 130, 135
Anglesite...90, 99, 100, 104, 108, 109, 115
,, after galena 25, 90
,, analyses of 109
Antimonite 15, 49, 87, 103
,, distorted crystals ... 15, 16
Antimony, Native 9, 49, 97
,, oxides 23, 32, 89, 111, 117, 119
Apatite 79
Aragonite 71, 93
Argentite 16, 18
,, after galena 17, 25
,, ,, ,, analyses of 17
,, ,, dyscrasite 16
,, ,, native silver 16
Armstrong—J. O. 38
Arsenic—native 9, 13
Atacamite 87, 102
"Atlasite" 111
"Aurichalcite" 111
Australite 62
Automolite 49
,, analysis of 49
Azurite 94, 99, 102, 106, 107
,, corroded 106
,, stanniferous 95

Balas ruby 61
Barite 91
Barrier Ranges—Mines of the..... 137
Barytocelestite 91
,, ,, analysis of 91
Basalt—columnar 62
,, enclosing sapphire 48
,, ,, zircon 48, 79
Beck—Professor..... 72, 73
Benson—Professor..... 73
Beryl 10, 31, 63, 67, 76, 81, 84
,, analysis of 64
,, enclosed in bismuth 65
,, etched and corroded 64, 76
Binary Compounds 15
Bindheimite 79, 116
,, analysis of 80
Biotite 31, 65, 67, 134
,, analysis of 66

Digitized by Google

INDEX—*continued.*

Page.

Bismite 10, **43**, 64, 76, 81, 95
Bismuth—Native ... **9**, 26, 31, 43, 64, 65, 85, 95, 134
,, ,, associated minerals 10
,, ,, endomorphs 10, 58
,, tellurate 32, 43, 93, 95
,, ,, analysis of 93
,, telluride 10, 26, 32, 93
,, ,, analyses of ... 26, 32
Bismuthinite 10, **17**, 65
,, endomorphs 17, 58
Bismutite 43, **95**
,, alluvial 95
,, enorusted with silver chloride 95
Black Sand (titanic iron)..... 61, 122
Blende **17**, 91, 113
,, ferriferous 17, **18**, 100
,, ,, analysis of 18
Boleite **37**, 105, 110, 111
,, analysis of 38
Bornite **18**, 19
"Bou[illegible]gerite" 108, 111
Bournonite **32**, **33**
,, analyses of 33
Breunerite 71, **101**
,, analyis of 101
Brochantite **91**, 92
Broken Hill Lode—Mineralogy of the 104
Bromyrite 111
Brongniardite 111
"Bungs" (ore bodies) 133, 134, 135

Cairngorm **59**, 62, 77
,, endomorphs 58, **59**, 77
Calamine 55, 79, **95**, 105, 106, 107
,, cupriferous 95, 96, 99, 107
Calcite ... 71, 87, **96**, 103, 113, 117, 118
,, after serpentine 74, 97
,, (Iceland Spar) 96
,, manganiferous 97
,, strontianiferous 97
,, with liquid inclusions 96
,, zinciferous 97
Calco-zinc carbonate 98
,, ,, analysis of 98
Caledonite 111
Camphylite 75, **81**, 111
"Canary Ore" (bindheimite) 79, 116
,, analysis of 80
Carbonates 93
Carbo-sulphate of lead 90
,, ,, analysis of 91
Card—G. W. 33, 46, 123, 132
Carmichael—A. D. 38
Cassiterite **43**, 56, 121, 135
,, associated minerals 126
,, enclosing rutile 60
,, endomorph 59
,, Occurrence of 121
,, sub-varieties—
"Leaf tin" 45
"Needle tin" 45

Page.

Cassiterite—*continued.*
,, sub-varieties—*continued.*
"Slime tin" 45
"Wood tin" 45
,, Cook's vein 123
,, Elliot Mine 122
,, Kennedy and Woolley's Mine..... 125
,, Pat and Battersby's Mine..... 121
,, Pipe of..... 125
,, Smith and Wilson's Mine 124
Cerargyrite... 23, 24, **38**, 68, 95, 105, 114, 115, 117, 118, 119
,, "shode slugs" 38, 39, 114
Cerussite ... 11, **39**, **55**, 90, 94, 96, **98**, 100, 102, 106, 107, 108, 114, 115
,, after galena 25, 99
,, ,, quartz 99
,, "arrow heads" 99
,, underlying sulphide ore 107
Cervantite 46
,, after antimonite 46
Chabasite 66
Chalcanthite **92**, 93
Chalcedony 59
Chalcocite **18**, 95, 102
,, after galena 19, 25
Chalcopyrite ...18, **19**, 30, 51, 56, 91, 134
Chalcotrichite 46
Chenevexite 80
,, analysis of 80
Chlorides, Bromides, Iodides and Fluoride 37
Chloro-antimoniate of silver ... **23**, 38, 39, 117, 118, 119
,, ,, after dyscraaite ... 24
,, ,, analyses of 24
Chloropal 66
,, analysis of 66
Chromite **46**, 70
Chrysocolla **67**, 106
,, analysis of 67
Chrysotile **74**, 101
Cinnabar **20**, 23
,, alluvial 20
,, associated minerals 20
,, "shode" 20
Citrine 59
Cobaltite **21**, **30**, 80
Columnar basalt 62
Common opal 54
Conradite 45
,, analysis of 45
Consols Lode—Mineralogy of the 116
Copper—Native **10**, 91, 92, 100, 107, 134
,, ,, enclosing native silver **13**, 15
,, ,, in fluorite 11
Corundum 46
Cosalite 33
,, analysis of 33
Covellite **19**, **21**
Covellite, after galena 25

Digitized by Google

INDEX—*continued.*

Page.

Cuprite 49, 102, 134
Cuproplumbite 21, 25
Cuproscheelite 84
Cuprotungstite 83, 89

Dana—Professor J. D. 6, 37, 70, 78, 132
Diamond 11
,, associated minerals 12
,, (boarts) 12
Descriptive Mineralogy..... 9
Dolomite 18, 29, 100, 102
,, analysis of 101
Dyscrasite 21, 22, 38, 103, 113, 117, 118, 119

Eisenkiesel 60
Embolite 39, 54, 69, 70, 94, 99, 102, 105, 106, 107
Emerald 67, 76
,, associated minerals 67
Endomorphs (unidentified) 58, 59
"Erinite" 111
Erythrite..... 21, 31, 80

Ferberite 31, 61, 84, 132, 135
,, alluvial 135
,, analyses of 85, 132
,, associated minerals 135
,, "bungs" 133, 134, 135
,, enclosed in quartz crystal 85
,, Occurrence of 132
,, Rockvale Mine 133
,, Wild Kate Mine 134
Ferric-tungstate—Hydrous 62
Fluorite ... 10, 19, 31, 40, 67, 84, 85, 135
Freibergite 36
"Freiseslebenite"..... 111

Gahnite (automolite)..... 49
,, analysis of 49
Galena 24, 103, 113, 114, 115, 117, 118
,, crystallized..... 25
,, enclosing dyscrasite 23
,, ,, tremolite 25, 78
,, endomorph 58
,, plumose 25, 108
,, pseudormosphism of 25
,, secondary 25, 108
,, "shode" 25
,, silver values 24
,, structure in relation to silver content 24
Galenobismutite..... 33
,, ,, analyses of ... 33, 34
Garnet 68, 111
,, almandine 68, 112
,, analyses of 68, 112
,, coated with silver chloride 68
,, grossularite 68
,, ,, analysis of 68
,, Occurrence of 111
,, ouvarovite..... 46, 70
,, ouvarovite, analysis of ... 70

Page.

Garnet Sandstone 25, 69
,, ,, analysis of 69
,, spessartite 25, 69, 71, 79, 110, 112
,, ,, analyses of 69, 112
Gold 12, 75, 110
,, in Broken Hill lode 110
,, matrices of..... 13
"Grass-stone" (rutile in quartz) 60, 78
"Green Rhodonite"..... 74
Greig—W.A. 31, 37
Greisen, (Topaz greisen) 76, 81, 132, 133 134
"Gray ore" 115, 116
Grossularite 68
,, analysis of 68

Halloysite 70, 71
Halotrichite..... 92
,, analysis of 92
Hammond—P. T. 109
Harrisite 19
Hedyphane.....81, 111
Hess—Frank L..... 84
Hlawatsch—Dr. C. 87, 110
Hübnerite 86
Hyacinth..... 78
Hyalite 54, 75
Hydros 96, 97
Hydrous ferric-tungstate 62

Iceland Spar..... 96
,, ,, liquid inclusion in.... 96, 97
Iodembolite 40, 110
Iodyrite 20, 21, 41, 50, 70, 94, 105, 107, 118

"Jalpaite"..... 111
Jamesonite 34
Jargoon 79
Jasper..... 60
Johnsonite 26
"Jordanite"..... 111
Joseite..... 26
,, analysis of 26

Kalinite 92
Kaolinite.....20, 70, 107 108
Kermesite 49
Kingsgate endomorphs 27
Knebelite 71
Kupfernickel 26

"Lanarkite" 111
Lead, Carbo-sulphate 90
,, ,, analysis of.. 91
"Leaf Tin" 45
Lime-zinc carbonate 98
,, ,, analysis of 91
Limonite 50, 95, 100, 106, 114, 115, 117, 118
,, after pyrite 13, 50
,, ,, siderite 50, 103, 117
Linarite 11, 91, 92, 105, 106, 107

Digitized by Google

INDEX—*continued.*

Page.

Liquid inclusions in calcite 96, 97
Liversidge—Professor 5, 35, 79, 110
Lollingite 26
„ analysis of 26

Magnesite 75, 101
„ ferriferous 101
„ „ analysis of 101
Magnetite 9, 30, 51
Malachite 37, 94, 95, 99, 101, 107
„ after azurite ...94, 101, 102, 106
Mangano-calcite 97
Map of Barrier Ranges field 139
Marcasite 27
Marmatite 17, 18, 100
„ analysis of 18
Marmolite 75
Marshite 41, 108
Massicot 51
"Matlockite" 111
Mawson—Sir D. 79
Melaconite 51
Melanterite 93
Mercury—Native 13, 20
Mercury—silver combinations 20, 21, 23, 42, 108
Mica schist 116, 117, 118
Miersite 41, 110, 111
Mimetite 80, 89, 105, 106, 107
„ corroded 106
Mineralogy of the A.B.H. Consols lode 117
Mineralogy of the Broken Hill lode 104
Characteristics 104
Identification 110
Occurrence of Garnet 111
Redeposition 113
Sequence 105

Mines—
Alfredamia 77
Allies 10, 17, 18, 27, 28, 29, 56, 87, 129
Atlas 39, 91
Attunga 66
A.W. 9, 10, 26
Baker's Creek 15, 16, 46
Bismuth 10, 26, 31, 40, 65, 80, 132, 134
Black Bird 38
Block 14 (*Torrington*) ... 58, 85, 133
Bobbie Burns 50
Bow Creek 87
Broadwater 13, 16, 20, 37
Broken Hill Lode ..... 5, 10, 11, 14, 17, 21, 25, 39, 40, 41, 42, 49, 50, 51, 54, 62, 67, 69, 70, 72, 73, 74, 75, 79, 80, 82, 90, 91, 94, 97, 98, 102, 104, 105, 108, 114, 117.
Block 10...11, 69, 80, 102, 105, 107, 111
Block 14...67, 74, 82, 85, 88, 90, 98, 102, 105, 107, 109
British...11, 25, 27, 73, 91, 92, 98, 105, 106, 107
Central...18, 57, 90, 98, 102, 107, 108

Page.

Broken Hill—continued.
Junction...14, 71, 82, 89, 96, 102, 105, 107, 108
Junction North 14, 25, 74, 102, 103, 112
North 14, 19, 21, 25, 82, 100
Proprietary.....11, 14, 15, 19, 20, 40, 41, 42, 49, 80, 82, 87, 88, 89, 90, 91, 93, 94, 96, 97, 98, 99, 100, 102, 105, 106, 107, 108, 110, 111, 117, 118.
South... 37, 42, 46, 49, 71, 72, 73, 75, 93, 96, 105, 108
South Blocks 59, 78, 97, 102
Budgery 11
Burley Jackey 18, 19
Burra (*South Australia*) 101
Butler 17, 55, 84, 135
Cadia 11, 46, 49, 51
Caroline 67
Carpathia 83
Central Greta 92
Cobar Gladstone 94
Commonwealth 91
Conrad... 15, 18, 19, 21, 24, 25, 31, 45, 56, 57, 58, 92, 93.
Consols—Australian Broken Hill...5, 9, 14, 15, 16, 17, 19, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32, 34, 35, 36, 37, 38, 39, 41, 42, 49, 50, 51, 55, 62, 75, 79, 80, 89, 91, 97, 102, 103, 105, 113, 114, 116, 118.
„ *Lucknow* (*Cadia*) 13, 97
„ (*Pinnacles*) 34
„ *Webb's* 19, 21, 25, 27
Cook's (*vein*) 123
Coopers'—A. E....9, 10, 29, 87, 129, 130
Copper Hill 101
Cordillera 83, 88, 89
Cosmopolitan 16
C.S.A. 10, 14, 100
Damifino 87, 88
Day Dream 79, 102, 103
Deep Shaft 12
Dick's (*Bodangora*) 11
Donoghue's—J. 81, 84, 134
Dutchman 55, 57
Eaglehawk 15, 114
East Consols ... 15, 21, 25, 41, 78, 83
Edwards' 40, 131
Eleanora 16
Elliot 19, 21, 122
Emerald 67, 76
Freehold 15
Garibaldi 96
Gem 25, 99
Gipsy Boy 25
Gipsy Girl 24
Gobondry 21
Golden Crown 91
Goldsworth 13
Goodwin's 97
Great Cobar...9, 10, 11, 19, 30, 49, 51, 94, 101, 119

Digitized by Google

INDEX—*continued.*

Page.

Gulf Creek 92
Hall's Peak 11, 25
Hart's 40, 44, 57, 59, 77
Heffernan's 63, 64, 65, 134
Hen and Chickens 79
Invincible 19
Iodide 41, 51, 100
Jingera (Whipstick field)...9, 10, 17, 26, 43, 68, 86
Kennedy and Woolley's 125
Kingsgate (field)... 9,10, 17, 26, 27, 28, 29, 30, 33, 55, 56, 58, 61, 85, 86, 128, 129, 130, 135.
„ *(Block 40)* 9, 10, 28
„ *(Block 45—Sach's)* ... 9, 28, 130
„ *(Water Cut)* 28
Kyloe (Poor Man's) 49, 102
Lady Brassey 17
Lady Carrington 34
Lily 39, 79
Lobb's Hole 27
Lucknow Consols 13, 97
Manbundi 129
Maurer's—G. P. 57
Maybell 15
Model Republic 38
Mount Costigan 92, 99, 100
Mount Fibro 54
Mount Hope 10, 94, 101, 102
Mount Ross..... 12
Mount Stewart...18, 30, 83, 96, 100, 103
Myall's United 13
New Hope 135
New Year 15, 39, 102, 115
Nine Mile 49
Ottery 17, 27, 30, 45, 83
Pat and Battersby's 121
Peak Hill 91
Perseverance 70
Phœnix 70
Pinnacles..... 30
Pioneer 90
Poor Man's (Kyloe) 49, 102
Potter's—T. A. R. 90, 115
Pulganbar 20, 37
Rare Metals 56, 57
Reform 9, 70, 74, 97
Restdown 132
Richard Ruby..... 100, 115
Rivertree (field) 18, 34, 35, 36, 50
Rockvale 86, 132, 133
Rumsby's ... 40, 55, 81, 84, 134, 135
Sach's (Kingsgate)..... 9, 28, 130
Silver Crest 38, 68
Silver King (Drake) 35
Silver King (Yerranderie) 34
Silver Peak..... 18, 25
Southern Cross 100
Smith and Wilson's 124
Sunny Corner 18, 50
Surprise 56
Tara..... 95
Tulloch... 14, 15, 27, 34, 35, 36, 97, 113
Tungsten Limited 83

Page.

Umberumberka ... 14, 35, 36, 103, 114
„ *East* 37, 102
United Miners 29, 36, 37, 100
Valla 27, 30
War Dance 38
„ *Extended* 36
Webb's 36, 37
„ *Consols* 19, 21, 25, 27
Weir's—H...... 86
West Bogan 101
Wheal Angus 100
Whipstick (Jingera field)...9, 10, 17, 26, 43, 68, 86
White Rock 35
Wild Kate 43, 58, 85, 133, 134
Wollondilly..... 97
Wunglebong (field) 17, 65, 84, 86, 135
Yerranderie (field) ...14, 24, 25, 35, 36, 37, 103, 114

Mines of the Barrier Ranges 137
Mingaye—J. C. H. ... 17, 18, 24, 26, 29, 30, 32, 33, 37, 49, 61, 64, 66, 67, 68, 70, 72, 73, 75, 80, 82, 83, 91, 92, 93, 101, 109.
Mispickel 27, 30, 113, 114
„ cobaltic 27
„ endomorphs 27, 58
Molybdenite 9, 10, 27, 30, 55, 84, 128, 135
„ associated minerals 131
„ distorted crystals ... 28, 29
„ endomorph 58
„ Occurrence of 128
„ oxidation of 87
Molybdite 43, 86
„ analysis of 86
Monazite 81, 84
„ analysis of 82
„ sand 81
Montanite 32, 43, 93, 35
„ after pyrite 93
„ „ analysis of 93
Morion 59
Moses—Professor A. J. 20, 42, 43
Muscovite 71

Nantokite 42, 105, 110, 111
„ analysis of 42
Native Elements 9
Natrolite 71, 94
"Needle Tin" 45
Norbeeck—Baron H. Foullon 110
"Onofrite" 108, 111

Opal—Common 54
„ Precious 51
„ replacements 53
„ Wood 54
Orthoclase 62, 71, 88
„ analysis of 72
„ green 72
Ouvarovite 46, 70
„ analysis of 70
Oxides 43

Digitized by Google

INDEX—*continued.*

Page.

Pegmatite 10, 31, 64, 65, 67, 76, **132**, 133, 134
" Phantom " crystals 58, 59
Phosgenite 102
Phosphates, Arsenates and Antimonate 79
Picrolite 75
" Pilarite " 111
Pittman- -E. F. ... 5, 17, 32, 89, 110
Platinum 13
Pleonaste 61
Polybasite **34**, 111
„ analysis of 34
Porter—D. A. 79
Precious opal 51
Prior—G. T. 41, 110
Proustite **34**, 114, 118, 119
Pseudophite 73
„ analysis of 73
Psilomelane—
39, 50, **54**, 94, 95, 98, 100, 106
Pyrargyrite ... 31, **34**, 113, 114, 118, 119
Pyrite **29**, 91, 101, 103, 113
Pyrolusite **55**, 62
Pyromorphite...54, **82**, 104, 105, 107, 108, 109
„ analysis of 83
Pyrrhotite **30**, 51

Quartz 28, **55**, 84, 85, 129, 130
„ citrine 59
„ distorted crystals 56
„ endomorphs in...10, 17, 27, 55, 58, 59, 60, 62, 77, 78
„ etched 57
„ Japanese twin 58
„ " phantom " crystals 58, 59
„ replacing ferberite 85
„ secondary 57
„ smoky 59, 62, 77
" Quartzite " (topaz-greisen) 132

Raspite **87**, 105, 110, 111
„ , analysis of 87
Rhodocrosite 100, **102**, 103, 108
Rhodonite **73**, 79, 110
„ , analysis of 73
„ , " Green " 74
" Ribbon " Scheelite 88
Rœpperite 74
„ analysis of 74
Rogers- Professor A. F. 70, 71
Rutilated Quartz (sagenite) 59, 60
Rutile 59, **60**, 121
„ analysis of 61
„ endomorph 59, 60
„ in cassiterite 60

Sagenite (rutilated quartz) 59, 60
Sapphire **47**, 68
„ associated minerals 48
„ enclosed in basalt..... 48
" Sartorite " 111

Page.

Scheelite **87**, 89, 135
Scheelite, alluvial 88, 135
„ " Ribbon " 88
„ replacement by wolfram? 88
Schwatzite 20, **37**
Scorodite 27, **33**
Secondary deposition 113
Selenite 93
Serpentine **74**, 101
„ chrysotile 74
„ marmolite 75
„ picrolite 75
Siderite **103**, 113, 114, 117
Silicates 62
Silver—Native...**13**, 15, 21, 40, **69**, 70, 96, 100, 105, 107, 113, 114, 115, 118
„ Native, after embolite ... 15, 40
„ „ in native copper... 13, 15
„ chloro-antimoniate ...23, 38, 39, 117, 118, 119
„ „ analyses of 24
Silver—lead—antimony sulphides ... 111, 114
„ „ analysis of ... 115
" Slime tin " 45
Smallite 10, 21, 30, 40, 64, 134
„ analyses of 30, 31
Smith, G. 117
Smithsonite 75
Smith—T. H.... 62, 68, 71, 78, 86, 87, 90
Spencer—L. J. 41, 110
Spessartite 25, **69**, 71, 79, 110, 112
„ analyses of 69, 112
Spinel 61
„ automolite..... 49
„ balas ruby 61
„ pleonaste 61
Stannite 31
Steatite 76
Stephanite **35**, 114, 118, 119
Sternbergite **31**, 114, 118, 119
Stilbite 75
„ (?) analysis of 75
Stilpnomelane 75
„ analysis of 75
Stolzite **88**, 105, 110
Stone—W. G. 18, 72
Stromeyerite 22, **31**, 114, 118
Strontiano-calcite 97
Sulpharsenites, Sulphantimonites, and Sulphobismuthites 32
Sulphates and Tellurate 89
Sulphides, Arsenides, &c. 15
Sulphur—Native 15
Tachylite..... 76
Talc 76

Tellurate of bismuth 32, 43, 93, 95
„ „ analysis of ... 93
Telluride of bismuth 10, 26, 32, 93
„ „ analyses of 26, 32
Ternary Compounds 32
Tetradymite **32**, 93

Digitized by Google

INDEX—*continued.*

Page.

Tetradymite, analyses of 32
Tetrahedrite... 23, **36**, 113, 114, 118, 119
„ after galena 25
„ analyses of 37
„ associated minerals... 36
„ enclosing dyscrasite 23
„ mercurial 20, 37
Thibault—P. J. 45
Titanic Iron **61**, 122
Tocornalite 20, **42**, 108
" Tomahawk iron " (limonite)..... 50
Topaz 31, 64, 67, 72, **76**, 123
„ associated minerals 77
„ *in situ*..... 72
Topaz-greisen ... 76, 81, 132, 133, 134
Tourmaline 77
„ auriferous 13, 77
„ endomorph 58, 59, 77
" Trap " 129, 131, 132, 133, 134
Treadwell—Professor 87
Tremolite 25, **78**
„ (?) endomorph 59, 78,
„ in galena..... 25, 78
" Tremolite-schist " 117
Tungstate—Hydrous ferric 62
Tungstates, Molybdates and Vanadate..... 83
Tungstite **61**, 85
Turquoise 83

Page.

Vanadinite 50, 80, **89**, **91**, 102, 105, 107

Wad 62
White—H. P. 17, 24, 26, 34, 66, **69**, **73**, 101, 112, 132
Willyamite **32**, 110
„ analysis of 32
Wolframite ... 61, 64, 65, 81, 95, **132**, 135
„ analysis of 132
„ Occurrence of 132
„ (ferberite) 61, 84, 132
„ „ alluvial 135
„ „ analyses of 85, 132
„ „ associated minerals... 135
„ „ " bungs of " ... 133, 134, 135
Wollastonite 78
„ analysis of 78
Wood Opal 54
" Wood Tin " 45
Wulfenite **89**, 105, **108**

Zinco-calcite 97
Zinc-lime carbonate 98
„ „ analysis of ... 98
Zinc sulphide, secondary 18, 25
Zircon 68, **78**
„ associated minerals 79
„ enclosed in basalt 48, 79
Zoisite 79

Sydney: Alfred James Kent, Government Printer—1926.

Digitized by Google

Digitized by Google

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. C. ANDREWS, Government Geologist.

MINERAL RESOURCES

No. ~~34.~~ 35.

The Yerranderie Silver Field

BY

L. F. HARPER, F.G.S.,

Senior Geological Surveyor.

Issued under the direction of R. W. D. Weaver, M.L.A., Minister for Mines.

SYDNEY: ALFRED JAMES KENT, I.S.O., GOVERNMENT PRINTER.

1930.

39—A

Digitized by Google

Science Library

TN
122
.N421
A3
no. 35

CONTENTS.

PAGE.

CHAPTER I.—Introduction and Acknowledgments 5

History and Previous References 6

CHAPTER II.—(A) Physiography 13

(B) General Geology—(1) Tertiary, (2) Triassic, (3) Palæozoic (Permian, Post Devonian, Upper Devonian, Upper Silurian) 15

CHAPTER III.—(A) Structural and Mining Geology—(1) Folding, (2) Faulting, (3) Lode Structures, (4) Ore Deposition, (5) Mineral Association 26

(B) Economic Geology—(1) General (2) Lodes 36

CHAPTER IV.—Individual Mines—The Colon Peaks, or Bartlett's Mine; The Silver Peak Mine, or Bore Block; the Wollondilly Mine, formerly the Yerranderie Mine; the Wonga, or Tonalli, Mine; the Great Western Mine; Coffey's Mine; Piece of Pork Mine; St. George Mine; the Silver King Mine; the Feldsworth Mine; Myall Ridge; the Silver Star Lodes (Terni Mine) 41

APPENDIX 1.—Report on the Colong Limestone Caves 59

APPENDIX 2.—Petrology—Notes by H. F. Whitworth, B.Sc., and J. Gordon McKern, B.E. 61

Digitized by Google

Geol. Survey of Mines - Australia
2-3-30

MAPS AND SECTIONS.

1. Geological Map of the Yerranderie Silver Field ..... At end.
2. Section A, B, C to accompany same ..... ,,
3. Section D, E, F ,, ... ,,
4. Locality Plan, Yerranderie ..... ,,
5. Plan showing Outcrops of Silver Lodes, Yerranderie ..... ,,
6. Colon Peaks and Silver Peak Mine Workings ..... ,,
7. Wollondilly and Burragorang Mine Workings ..... ,,
8. Wonga Mine Workings ..... ,,
9. Great Western Mine Workings ..... ,,
10. Plan showing position of Coffey's Bores ..... ,,
11. Plan of Colong Caves Area ..... ,,

ILLUSTRATIONS IN TEXT.

PAGE.
1. Diagrammatic Section, illustrating Earth Sculpture 13
2. Section of dyke and lode, Wollondilly Mine 20
3. Section illustrating unconformity between Silurian and Devonian Sediments, Kowmung River 24
4. Hanging and footwall lodes, Silver Peak Mine 32
5. More than one period of lode filling, Colon Peaks Mine 34

Digitized by Google

LIST OF PLATES.

PLATES.

1. View from Burragorang Mountain ..... *Frontispiece*

FACING PAGE

2. Yerranderie (Burragorang) shortly after mining commenced 6
3. Portion of the Tonalli River Valley 13
4. Irregular Sky-line—Northern boundary of the Yerranderie Amphitheatre 14
5. Valley of the Tonalli River, looking north-west 15
6. Outcrop of Silurian Beds, east side of Kowmung River, looking south; Mount Colong (basalt) in the distance 25
7. Western end of the Yerranderie Amphitheatre, looking north-west; the Silver Peak Mine in foreground 26
8. Boulder of quartzite of Devonian Age, embedded in basal beds of Upper Marine Series. Probably an erratic. (Note bent bedding planes in underlying sediments) 18
9. Horse team with ore; the Silver Peaks Mine dump in background 11
10. The Silver Peak Mine, looking west 45
11. The Silver Peak Mine 46
12. Head-gear, the Silver Peak Mine 47
13. The Wollondilly Mine (formerly Yerranderie Mine), looking west 48
14. The Wollondilly Mine, looking south-west; the Far Peak in the background 49
15. The Wonga (formerly Tonalli) Mine; the Far Peak on the left 51

ELEVEN TEXT PLATES.

PAGE.

Geological Map, and two Sections ..... At end

Map showing Lode Outcrop 36

Locality Map of Mines 41

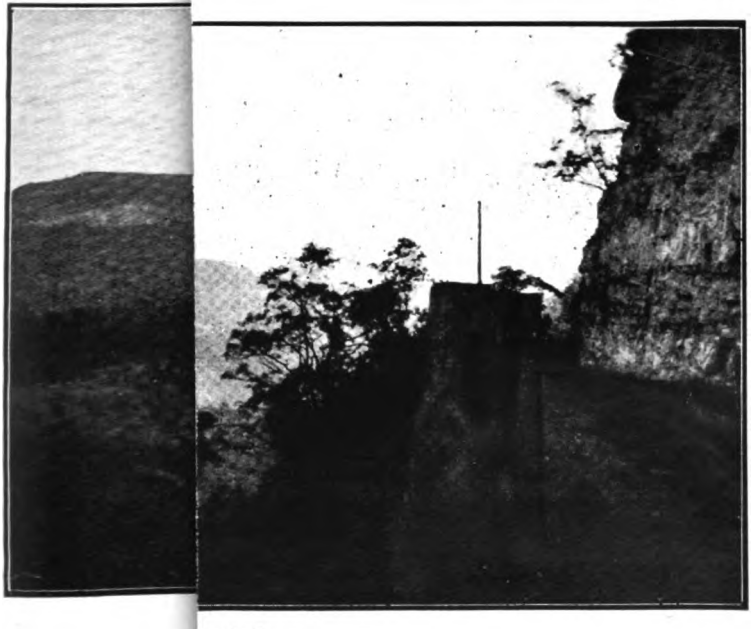
Four Mine Plans—The Colon Peaks-Silver Peak Mines, Wollondilly-Burragorang Mines, Wonga Mine, Great Western Mine ..... At end

Plan showing Mining Leases in force, 1924 ..... At end

Digitized by Google

PLATE I.

Frontispiece.



randerie.

Digitized by Google

CHAPTER I.

THE YERRANDERIE SILVER FIELD.

INTRODUCTION AND ACKNOWLEDGMENTS.

THE Yerranderie Silver Field is situated within 60 miles in a direct line from the General Post Office, Sydney, and is conveniently reached by train to Camden, 42 miles, whence a daily motor service runs to Yerranderie, 42 miles distant.

Although so close to the metropolis, the general public do not appear to be very familiar with conditions there, nor to have much idea as to the past output and future possibilities of this field as a producer of silver and lead.

The field is an important one, the value of the production to date exceeding £2,000,000. There appears to be an excellent prospect of the field maintaining its position as an important mining centre for years to come provided the prices of silver and lead do not fall appreciably, and provided also that prospecting and development work be not neglected.

With a view of obtaining a more detailed knowledge of the geology of this, the nearest metalliferous mining field to the Metropolis, together with information as to future prospects, the writer was instructed early in 1923, to carry out a geological survey.

It is desired to acknowledge the facilities afforded by mine-owners, managers, underground managers and all connected with the field.

The late Mr. J. V. Bartlett, the pioneer of Yerranderie, largest shareholder in the Colon Peaks Mine, and sole lessee of adjacent areas along the line of Bartletts, or the main Yerranderie lode, afforded every facility for obtaining desirable information, and furnished mine plans, together with valuable historical data.

Mr. A. F. Mixner, manager of the Silver Peak mine, afforded every facility for examining that mine, and also kindly supplied the fine set of photographs from which the plates published herewith were produced.

Mr. J. T. Hardman, manager of the Wollondilly mine, placed the mine office at the disposal of the geologists engaged in the work, and supplied much useful information.

Mr. C. Roberts, who has been associated with the Yerranderie field for over twenty years, and is at present manager at Colon Peaks mine was a valuable source of information, which he supplied most willingly.

Mr. T. L. Willan B.Sc., Field Assistant, was associated with the writer during the geological examinations, and rendered useful assistance. He also in part prepared maps, plans, and sections for reproduction, and collected a comprehensive series of rock samples for microscopic examination.

Mr. J. Gordon Mc. Kern, B.E., late Petrologist to the Geological Survey, carried out a careful microscopic examination of the various rocks collected during the survey, and his determinations were of great help in arriving at conclusions as to the origin and nature of the volcanic rock series.

Digitized by Google

At a later period Mr. H. F. Whitworth, Petrologist to the Geological Survey, visited the Yerranderie field, after having microscopically examined the rocks previously collected.

Additional samples were obtained by Mr. Whitworth, who also studied the field occurrence of the various rock types. His detailed petrological notes and deductions are included as Appendix A, and should form an excellent basis for any future exhaustive petrological study of this area.

HISTORY AND PREVIOUS REFERENCES.

The Yerranderie Silver Field was formerly known as The Peaks, Burragorang, and although it is an old settled district, successful mining on the field is of comparatively recent date.

Mr. R. H. Cambage F.L.S., late Under Secretary for Mines, has compiled an interesting historical record of the first exploration of this belt of country by Whiteman* and a short epitome of the article may not be out of place here.

"Not long after the first settlement at Sydney in 1788, the necessity for expansion, and the desire to acquire more information regarding our wonderful heritage became all important. The rugged sandstone battlements of the Blue Mountain Range offered considerable difficulties to the explorer, but in 1802, Ensign Francis Barrallier obtained permission from Governor King to explore the country to the south-west of Sydney, and endeavour to cross the Dividing Range.

The expedition started from Parramatta in November, 1802, and traversed the country through Prospect Hill towards the Nepean River adjacent to where Camden now stands. The course pursued took Barrallier very close to the spot now occupied by the town of Picton, after which he turned westward and crossed the Nattai River, which he followed down about 6 miles to its junction with the Wollondilly. Thence he ascended the right bank of the latter river for about half a dozen miles, when an opportunity to again travel westward presented itself. The journey was continued across the Wollondilly and up the ranges a little south of the present village of Yerranderie."

By a careful research and study of Barrallier's diary, Mr. Cambage was able to trace his course to the south of Mount Colong (at a spot now known as Barrallier's Pass, see geological map herewith).

After further exploration the intrepid pioneer was compelled to turn back, "having failed in the accomplishment of what I had planned, namely, going over the Blue Mountains by the route I had thought of."

During the next fifty years numerous settlers found their way into the Burragorang valley, being attracted by the fertility of the river flats. Apparently it was not until 1871 that the first discovery of silver-lead ore was made. The writer was informed by Mr. Martin Feld, an old resident of the district, that in 1871 two men named Billy Russell and Billy George, the former a half-caste, found galena at a spot about 2 miles east of the site of the present Yerranderie Post Office, where the Feldsworth Mine was subsequently established.

* Journ. and Proc., The Aust. Historical Soc. Vol. III,, Part 1, p. 11, Sydney, 1915.

Digitized by Google

Yerranderie (Burragorang) shortly after mining commenced—The Far Peak.

Digitized by Google

Digitized by Google

These men sent about 3 cwt. of ore to Mr. A. J. Liddington, of Luddenham, and in 1874 he applied for a mining title over the area, (Application 1874/1, Camden) which was surveyed as portion 54, parish of The Peaks, county Westmoreland. Practically no prospecting appears to have been done and the title was abandoned.

In 1885 F. C. Shadforth applied for a mineral lease of 20 acres covering portion of this occurrence, but very little effort was made to work it, and the lease was forfeited. At the same time about twenty other mineral leases were applied for south of Basin Creek by various Sydney residents.

Prospecting appears to have been carried out intermittently during the following decade, as evidenced by a sample submitted to the Department of Mines for assay in 1890, which gave the following result :—

Ferruginous quartz rubble, yielding—

Silver, 27 ozs. 12 dwts. 0 grs. per ton.

Gold, 3 „ 6 „ „ „

In 1894 Mr. E. F. Pittman, at that time Government Geologist, visited the field, and submitted a report* in which, after describing the limited amount of prospecting carried out on Cuneo's propsecting area up to that period, points out that future prospects are greatly handicapped by the nature of the occurrences and difficulties of transport.

It is now difficult to locate the exact position of Cuneo's prospecting area, but there are good grounds for assuming that it was on the eastern side of M.L. 12, parish Colong, as shown on the accompanying map, and now held by Mr. J. V. Bartlett. It would appear from Mr. Pittman's report that most attention was being paid to lodes striking a little east of north, and it is doubtful if the main Yerranderie lode, which has a more or less east and west strike, had been located at that period.

In 1897 Mr. J. V. Bartlett appears to have been attracted by the possibilities of this hitherto unproductive field, and there is no doubt that his enterprise and energy were important factors in subsequent developments.

In the Annual Report of the Department of Mines for 1897, page 191, Mr. G. W. Card, Curator and Mineralogist, points out that "Prospecting in the Burragorang District has been continued; samples of quartz, ironstone, and galena assaying up to 250 oz. and cerussite nearly 500 oz. to the ton." (Silver L.F.H.)

In 1898 active mining was being carried out on the field, and it appears probable that the main Yerranderie lode was first worked early in December of that year.

---

* Annual Report, Dept. of Mines, Sydney, 1894, pp. 104, 105.

Digitized by Google

The following information was published in the Departmental Annual Report*:—

PICTON DIVISION.

"In February, 1898, two parties, Messrs. Webb and Mackie and J. V. Bartlett, applied for authorities to enter on a conditional lease owned by Harold C. Manning, to mine for silver. This conditional lease is situated about 10 miles from the Wollondilly River, about 40 miles from Picton, and about 43 from Camden. Both parties referred to have been actively engaged mining on the areas they applied for. Webb and Mackie have had treated about 60 tons, which returned them 3,420 oz. silver, averaging 2s. 3d. per oz.; 20 tons of lead, averaging £12 15s. per ton, and 6 oz. gold, averaging £3 17s. 6d.; or a total of £660. An average of eight men have been employed. J. V. Bartlett has raised and sent away a large quantity of ore, reputed to be richer than that of Webb and Mackie's. In October a fresh stir took place, and four other applications were made, chiefly for 40-acre blocks, on the same lease. Later on eight other applications were lodged, and at present 302 acres of this lease are held under authorities to enter. Work is progressing well on all the areas, and about sixty men are employed there in mining. On an adjoining conditional lease two areas, to the extent of 80 acres, are held under authorities to enter, and are worked by eight men. Besides those mentioned there are 120 acres now applied for awaiting allotment. Altogether there are about eighty men at work on the field. On Crown lands a number of claims have been pegged, and are being worked as mineral prospecting areas.

"A large company is now being formed to work the mines systematically."

Reference is made in the same annual report to Mr. J. V. Bartlett having received aid from the Prospecting Vote, and that as a result he had struck some very rich ore. Subsequent developments on the Yerranderie field is another instance of the useful purpose served by the granting of Government assistance to prospectors.

Information with regard to the course of events, and the part played by the various prospectors at this stage, is rather conflicting, but appears to favour the following:—Mr. Webb, who held a sub-lease from Mr. Bartlett during 1898, appears to have been working a claim, afterwards known as the St. George. Mr. Bartlett found the outcrop of the main Yerranderie lode, which has subsequently been worked with such satisfactory results. Messrs. Webb and Mackie were given their choice of claims, and decided to take the St. George's area, and the new discovery was pegged out by Mr. Bartlett.

Some very rich silver assays had been obtained from the St. George area, one fragment returning values at the rate of 3,000 oz. of silver to the ton. The lode was very patchy, however, and it would appear that the total value of ore recovered did not exceed £800. (See returns on page 54.)

Meanwhile Mr. Bartlett commenced to develop his new discovery with assistance from the Prospecting Vote,† J. Field and J. Sherritt being the first miners to put pick into the lode.

---

* Annual Report, Dept. of Mines, Sydney, 1898, p. 68.
† Annual Rept., Dept. of Mines, Sydney, 1898, p. 10.

Digitized by Google

Trouble then arose between Messrs. Bartlett and Webb, and litigation followed. Mr. Bartlett's claims were upheld, and he has since continuously worked the area pegged out by himself with highly satisfactory results, having recovered ore with an estimated total gross value of well over half a million sterling.

At this period (1898) further attempts were made to work the Feldsworth Mine, and 2 tons 14 cwt. of ore were sent to Dapto for treatment, the net return from which was £100 2s.

An area known as Poverty Point, a little to the north of the St. George Mine, was also being prospected, and a man named Williams sent 6 tons of ore to Cockle Creek for treatment. Results were unsatisfactory, however, and work there was abandoned.

During 1899 some 150 men were employed on the field, and the returns obtained were satisfactory despite the difficulties and cost of transport.

A report on the field was furnished in 1899 by Mr. E. F. Pittman, at that time Government Geologist.*

Mr. Pittman referred again to Cuneo's lode and to two other lodes discovered by Mr. Webb and Mr. Bartlett.

Bartlett's lode is referred to favourably, and returns given show that 220 tons of ore yielded 11,388 oz. of silver, 25 oz. of gold, and 12·03 tons of lead.

The future prospects of the field are favourably reviewed, and assistance from the Prospecting Vote is suggested in order to construct a road of access.

The Wollondilly Mine (late Yerranderie Mine) appears to have started about this period, and was known as Hilder's Claim.

During the year 1900, the existing mines were all producing, and efforts were being made to develop new properties. Messrs. Kerry and Mayes commenced boring to test Bartlett's lode on the underlay within the area since so successfully worked by the Silver Peaks Company, but still spoken of locally as the Bore Block Mine.

In 1901, Mr. J. B. Jaquet, Chief Inspector of Mines, but at that time Geological Surveyor, furnished a report on the "Burragorang" silver field,† in which he discusses a proposal to locate Bartlett's lode on the underlay by means of the diamond drill. In conclusion it is pointed out that recent developments have proved beyond doubt that the silver-bearing lodes of Burragorang are of a permanent character.

In 1902, information was contained in the Annual Report for that year.‡

The failure of the bore to prove Bartlett's lode on the underlay is referred to, also the improvement in the road of access. At that period conditions on the field appear to have been good, and a large output of ore had resulted.

During 1903, Mr. Jaquet again reported on the field,§ and supplied information with regard to the various mines. It is interesting to note that the opinion was then expressed that Bartlett's lode and the Yerranderie (Wollondilly) lode were distinct.

Considerable mining activity was displayed during 1904, and the returns were more than double that of any previous year.

---

* Annual Report, Dept. of Mines, Sydney, 1899, pp. 162–164.
† Annual Report, Dept. of Mines, Sydney, 1901, pp. 165–6.
‡ Annual Report, Dept. of Mines, Sydney, 1902, p. 46.
§ Annual Report, Dept. of Mines, Sydney, 1903, pp. 130, 131, and map.

Digitized by Google

During 1905, the tonnage of ore raised was slightly less than in 1904, but the net value was greater. This may be accounted for in part by the higher gold content recovered, and also to an increase in the prices of metals.

In 1906, despite the favourable prices of metals, the progress of the Yerranderie Silver Field was somewhat disappointing as regards tonnage of ore raised and sold, which fell short of the previous year by over 1,000 tons. 1907 and 1908 were more satisfactory, however, and the latter year was probably a record one as regards number of men employed (351), and output of ore marketed 7,402 tons, with a net value of £114,029.

In 1909, Mr. E. F. Pittman, Government Geologist of New South Wales, furnished a further report on the field,* and in his general conclusions points out that "the work done on the Yerranderie Silver Field during the past decade shows that the lodes are persistent in depth, and that they contain deposits of silver-lead ore of high grade."

The production eased off during 1910 and 1911, but increased again in 1912, and owing to metal prices during that period being favourable to the producer, returns were very satisfactory, although the tonnage of ore marketed was not as great as during 1910.†

In 1913 there was an average of 290 miners employed at Yerranderie, but returns were again lower.

In 1914, Mr. Pittman furnished a further report on the field‡ in connection with a proposed railway, and pointed out that there was a large quantity of second-grade ore which would pay to send away if there was a railway.

In December, 1914, Mr. J. H. Fawcett, M.I.M.M., Mining Engineer, furnished reports on both the Yerranderie and Silver Peak mines to their respective directors.

At that period both mines appeared to have largely exhausted their visible supply of prill ore or ore of first grade for shipment, and Mr. Fawcett paid particular attention to the probable tonnage and values of second-grade ore available for milling. With reference to the Yerranderie Mine, he favoured extending one of the upper levels into the virgin ground west of the break, which, if favourable developments occurred "would mean practically a new mine."

In this connection it may be pointed out that the present holders of this mine are making every effort to carry out prospecting in this direction, with very favourable results to date.

With regard to the Silver Peak Mine, Mr. Fawcett pointed out that up to the time of his visit developments had disclosed only a comparatively small reserve of first-class ore, but a fair tonnage of seconds, which would pay to treat. He strongly advised the westerly extension of No. 4, 7, and 8 levels, and it is interesting to note that the recent (1923) opening up of highly satisfactory ore bodies have all been located in the western extension of the workings.

The year 1915 saw a revival in the tonnage of ore marketed, due to the treatment of a considerable quantity of "seconds." 1916 was a bad year for the field, the total quantity of ore raised and sold being the lowest for some years, but the output again increased during the ensuing three years.

---

* Annual Report, Dept. of Mines, Sydney, 1909, pp. 176–7.
† Annual Report, Dept. of Mines, Sydney, 1914, pp. 187–189.
‡ Annual Report, Dept. of Mines, Sydney, 1912, p. 43.

Digitized by Google

was
akes

date,
and
one."
uring
a due
k by
This
had
ralia,

way,
2 had

n the
en no
of ore
dually
ate of
imate
tons;
, and

nce it
-grade
nillion

ales in
overy,

ns of a
derlay.
Messrs.

at 10s.
rs and

s paid,
o 1916
derable
. Five
an paid
he past
of the
f No. 6
d, and

Digitized by Google

PLATE IX.

Digitized by Google

A report by Mr. J. E. Carne, at that time Government Geologist, was furnished in 1916* dealing with a proposed line of railway from Picton Lakes to Yerranderie.

This report gives a summary of conditions and production up to date, and points out that "under the most favourable aspects, however, full and regular employment for a railway cannot be looked for from mining alone."

From 1917 to 1920 the ore raised and sold steadily increased, but during 1921 and 1922 the tonnage was much less. This appears to have been due in part to the restricted smelting operations carried out at Cockle Creek by the Sulphide Corporation Limited, owing to the strike at Broken Hill. This company ceased customs smelting entirely in 1922, and arrangements had to be made to despatch the Yerranderie ore to Port Pirie in South Australia, distant over 1,500 miles from the mines.

Owing to the cost of transport, only high-grade ore could be sent away, and developmental work in the mines up to practically the end of 1922 had not disclosed any large deposits of that character.

In 1921, Mr. L. J. Jones, Geological Surveyor, furnished a report on the field,† and pointed out that since Mr. Carne's report "there has been no extensive developmental work carried out, no additional rich chutes of ore have been located, and the ore reserves then in sight are being gradually depleted." Tables of past output and values are given, also an estimate of "a fair annual output from existing mines." The totals of this estimate are as follows:—Ore raised, 16,350 tons—first-grade ore, 4,650 tons; second-grade ore, 11,700 tons—yielding 2,120 tons of concentrates, and giving a total for shipment of 6,770 tons.

The Colon Peaks Mine has been controlled by Mr. J. V. Bartlett since it was first worked in 1897, and has been a consistent producer of high-grade silver-lead ore ever since, having returned nearly three-quarters of a million pounds worth of bullion.

The record of this mine is somewhat remarkable in New South Wales in that practically no capitalization has been necessary since its discovery, all costs being met by the ore won.

The Silver Peak Mine area was partly prospected in 1901 by means of a percussion drill, with the object of locating Bartlett's lode on its underlay. Results were not very satisfactory, and the original prospectors, Messrs. Kerry & Co., sold out their interests for about £600.

The present company was formed in 1904 with 60,000 shares at 10s. each, but the available capital was expended within a couple of years and very little ore recovered.

Further capital was raised, and in April, 1908, the first dividend was paid, four 6d. dividends being again paid in 1909. From that year up to 1916 there was trouble over the ownership of the leases, and considerable litigation took place, but in 1917 the company again secured control. Five or six lean years followed, with a bullion recovery that little more than paid expenses, but in 1923 the mine prospects greatly improved, and for the past two years excellent returns have been obtained. As an example of the productivity of this mine since 1923, it is claimed that one stope off No. 6 level produced in fourteen months 20 tons of silver, 1,700 tons of lead, and 562 oz. of gold, the actual length of the ore lens being 135 feet.

* Annual Report, Dept. of Mines, Sydney, 1916, pp. 193–197.
† Annual Report, Department of Mines, Sydney, 1921, pp. 70–73.

Digitized by Google

Early in 1923 the Yerranderie Mine was closed down, and an option over the property was secured by Mr. William Tarleton from the Yerranderie Silver Mining Co., No Liability, who had paid dividends amounting to over £80,000.

The terms of the option were £1,750 cash, of which £350 was to be paid by May, and the balance by equal payments in July and August.

Mr. Tarleton obtained a report on the property from Mr. J. T. Hardman, a well-known mine manager, who has had considerable experience in this and other States of the Commonwealth.

Largely as a result of this report, a small company was formed with a capital of £6,000, and registered as Wollondilly Silver Mining Company, N.L. The capital was divided into 5,000 preference shares of £1 each and 20,000 deferred shares of 1s. each (issued to the vendor fully paid to 1s.)

Work was commenced at the mine about the middle of May, 1923, and the output for the last six months of that year was 191 tons of ore, valued at over £22 per ton. In addition, 45 tons of concentrates, valued at £16 per ton, were recovered. This return in such a short period from a practically abandoned property appears to justify fully its acquisition, and future developments should result in a substantial output. There is a length of some 500 feet of untried country within the company's leases west of the existing levels, in which it is reasonable to expect further good makes of pay ore, so that future prospects are apparently bright.

TABLE of output from the Yerranderie Silver Field, 1898–1925.

Year.	Ore raised and sold.	Metallic Contents of Ore.			Gross value received.
		Gold.	Silver.	Lead.	
	tons.	ozs.	ozs.	tons.	£
1898–1899	.....	.....	.....	.....	5,500
1900	616	101	53,527	118	9,125
1901	952	174	86,017	125	11,000
1902	1,553	306	146,018	229	18,373
1903	1,293¼	308	145,275	217¼	18,304
1904	3,733	550	263,621	448¼	32,068
1905	3,527	707	243,403	451	37,559
1906	2,473	557	223,572	439	39,156
1907	4,469	862	479,243	1,005	80,852
1908	7,402	1,293	828,129	1,892	114,029
1909	6,650	1,231	719,264	1,654	99,374
1910	7,338	1,399	783,295	1,873	113,071
1911	6,606	1,025	728,340	1,674	105,600
1912	7,055	1,438	676,095	1,906	121,859
1913	5,163	1,070	475,866	1,458	77,546
1914	4,614	1,061	520,880	1,269	82,053
1915	7,021*	735	475,180	1,302	81,066
1916	1,649	234	174,321	585	41,887
1917	3,484	420	276,034	1,054	77,355
1918	4,296	670	317,459	883	88,046
1919	5,496	714	286,955	861	78,528
1920	6,884	439	299,123	740	88,869
1921	2,912	343	250,000	552	50,574
1922	3,643	621	294,756	1,035	64,630
1923	5,151	928	575,491	1,662	123,917
1924	5,417	784	464,516	1,213	106,022
1925	1,211	217	111,532	317	27,603
28 years.	110,608¼	18,187	9,897,906	24,962¼	1,795,966

* Includes 4,566 tons of second-grade ore.

Digitized by Google

Main
o the

Main
falls

River,
lopes
derie
aded,
ivide.
east
y the

, and
raight
tream
rater-

ating
t has
matic

ed in
form
which

ted in

Digitized by Google

Early
the prop
Silver M
£80,000.
The t
by May,
Mr. T
a well-k
and othe
Large
capital
The cap
deferred
Work
the outp
at over
ton, wer
abandon
develop
some
exist
pa

Digitized by Google

CHAPTER II.

(a) PHYSIOGRAPHY.

The Yerranderie Silver Field is situated on the eastern slopes of the Main Dividing Range, from which it is distant about 14 miles in a direct line to the nearest point.

Mount Werong (4,005 feet above sea-level) is the highest point on the Main Divide in this locality, but the range, as a rule, is of no great width, and falls away rapidly to both the eastern and western drainage areas.

The field is separated from the Divide on the west by the Kowmung River, the various feeders of which have considerably dissected the eastern slopes of the range. By travelling in a south-westerly direction from Yerranderie towards Barrallier's Pass, however, the waters of the Kowmung are headed, and a more or less gradual ascent is made to the summit of the Main Divide.

Yerranderie is within the watershed of the Tonalli River, which flows east into the Wollondilly river, the waters of which flow thence to the sea by the Warragamba, Nepean, and Hawkesbury Rivers.

The Tonalli rises at an altitude of about 2,400 feet above sea-level, and junctions with the Wollondilly at an altitude of about 300 feet. In a straight line, these two points are less than 12 miles apart, but owing to stream meanders, the average fall in the Tonalli is about 60 feet per mile. No waterfalls occur, but in places the river bed forms short rapids.

Owing to the nature of the strata within this belt of country, i.e., alternating hard and soft, comparatively flat bedded rocks, stream development has resulted in earth sculpture as depicted in the following diagrammatic section :—

DIAGRAMMATIC SECTION

1. Triassic sandstone.
2. Permo-Carboniferous (a) Upper Coal measure, shales &c., (b) Upper Marine sandstone and conglomerate with argillaceous bands.
3. Devonian lavas, pyroclastic rocks, and silicified shales and quartzites Conglomeratic in part.

The uneven disintegration of the Triassic formation (1) has resulted in disconnected precipitous exposures of the rocks of that period, which form small outliers on the southern and north-western side of the field, but which continuous to the north. (See plate IV.)

The underlying Upper Coal Measures, (2a) mainly shales, have resulted in gentle slopes, whilst the Upper Marine beds, consisting mainly of massive sandstones, and pebbly conglomerates, have also weathered into vertical cliff faces. Below these, the beds of Devonian age have been exposed over

Digitized by Google

a somewhat limited area. They consist for the most part of lava flows and pyroclastic rocks, with which are associated conglomerates, sandstone, and arenaceous mudstones, all more or less highly silicified. These beds have resisted weathering to a large extent, and the actual bed of the Tonalli River occupies for the most part a V-shaped gorge with precipitous cliff faces in places, and excavated to a depth of some 200 feet below the adjacent limits of the broad U-shaped valley.

The altitude at the Yerranderie hotel is about 1,925 feet above sea-level and is practically on the tops of the broad portion of the Tonalli River valley.

The Far Peak, situated less than one mile west-south-west of the hotel, rises to an altitude of approximately 2,750 feet, and is a vantage point from which the main topographical features of the district may be seen in their general relations to each other and to the local geology.

The lower cliff face on this Peak is of Upper Marine age, and the gentle overlying slope is formed by beds of the Upper or Newcastle–Bulli Coal Measures, whilst the top bluff is composed of Triassic sandstones, which here have been intruded by an igeneous rock of post-Triassic age. Another excellent panoramic view may be obtained from the cliff line behind the Pulpit Rock, on the opposite side of the Tonalli River. This rock consists of a mesa of Hawkesbury sandstone, to which access is not possible without artificial means. The top of the bluff is probably less than one acre in extent and lies at an altitude of over 2,200 feet above sea-level.

The descent of the Tonalli River by the most accessible route from the hotel exceeds 1,000 feet, and the height of the ridge on the opposite side exceeds 1,400 feet.

The field is encompassed on three sides by precipitous cliff faces with occasional gaps (Byrne's, Bull Island, Colong, &c.) due to the removal after disintegration of the sandstone beds forming the escarpments.

To the south, west, and north-west these beds are of Upper Marine age, but the northern cliff line consists of beds of Triassic age.

The cliff lines converge to the west, and in that direction completely enclose the valley of the Tonalli, but are here considerably dismantled. At the village of Yerranderie the cliffs are separated by about 5 miles of steep ridges and gullies, and the gorge of the Tonalli River with its broken cliff faces, not in the centre of the valley, but about two-thirds of the way across from the southern rim of the ampitheatre.

The view from the western rim of the Tonalli watershed is one of grandeur. The country falls away rapidly into the gorge of the Kowmung River, from 1,000 to 2,000 feet below, the bed of which is little more than a mile distant in a direct line. One thousand feet above the stream, the valley has a width in places of less than 2 miles, and the topography differs from that found in the Wollondilly valley owing to the strata through which the gorge has been cut consisting for the most part of vertically dipping slates and limestones. Here mural escarpments give place to steep slopes intersected by V-shaped gullies, the latter containing a dense growth of scrub. The majority of the slopes are unclimbable. The limestone belt stands out boldly, with numerous broken cliff faces, and at its southern end a number of limestone caves known as the Colong Caves.*

* Trickett, D. See Appendix—Also Annual Report, Dept. of Mines, Sydney, 1899, pp. 211-12.

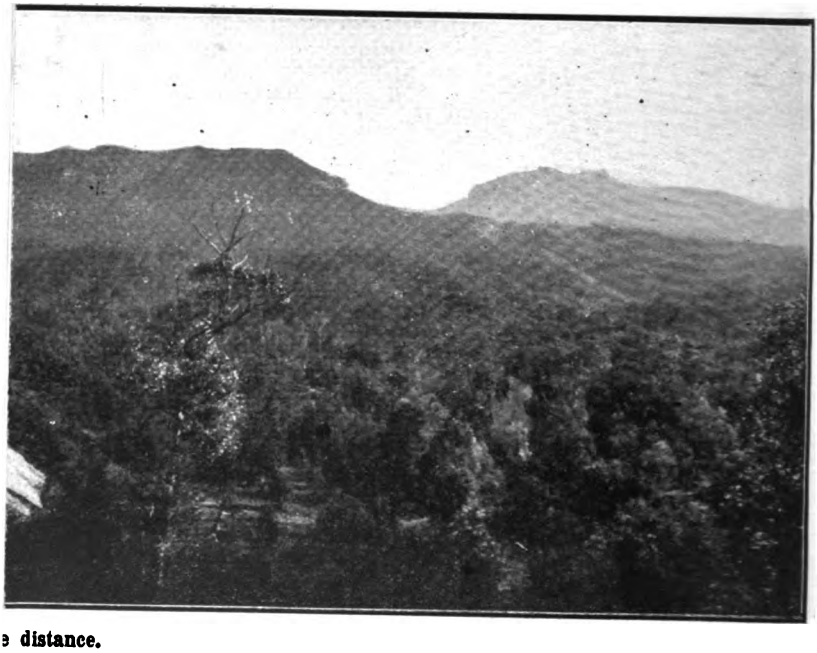
Digitized by Google

To face page 14.

ne.

Digitized by Google

To face page 15.



e distance.

Digitized by Google

The particular portion of the Blue Mountains included in the area dealt with in tnis paper is described by Mr. R. H. Cambage as "one of the very roughest and most inaccessable parts of the Blue Mountains."*

At th present time there are only two or three bridle tracks available by which access may be gained to this belt of country, and the services of a guide are almost essential.

The climate within the area under review has a fairly wide range, owing to the differences in altitudes, which vary from 246 feet above sea-level, 13 miles north-east of the village, in the bed of the Nattai River at the crossing, to 3,436 feet at the top of Mount Colong, 4 miles to the south-west.

During the summer months temperatures exceeding 100 degrees Fahrenheit are not uncommon. It cools off only slightly at night in the valleys, but there is a considerable drop in temperature on the top. In the winter months frosts are common at Yerranderie itself and dams or stagnant pools of water are on occasions fringed or coated with a thin film of ice, whilst occasional heavy falls of snow occur on the Main Dividing Range to the west.

Westerly winds are prevalent both during summer and winter, being hot in the former and very cold during the latter period.

The botany of this belt of country has been described by Mr. R. H. Cambage, late Under Secretary for Mines.†

One point in this connection is worthy of mention. The "dwarf tree-fern" as it is sometimes called (*Todea barbara* C. Moore) has been observed by the writer in other parts of the State to markedly though not exclusively favour the chocolate shale horizon of the Narrabeen Stage, Hawkesbury Series.

Mr. Cambage records the presence of this fern between Colong and Mount Werong,‡ and along Butcher's Creek on the northerly fall from the Tonalli River.‡ The writer observed this fern particularly on the steep slopes just below the sandstone cliffs bounding the Tonalli watershed on the north, and an examination of the rock formations disclosed the presence of the chocolate shale horizon, here some 30 or 40 feet thick.

Owing to the dip of the beds and surface contours Butcher's Creek has exposed this horizon over a considerable length, remnants of which are also found near Mount Colong. The signifiance of the above has been so impressed upon the writer that the presence of *Todea barbara* always calls for geological investigation.

(b) GENERAL GEOLOGY.

Owing to the amount of denudation that has taken place within the area under review, together with the stratigraphical conditions pertaining, the geological formations exposed have a considerable range in period.

---

* Ensign Barrallier's Blue Mountain Exploration in 1802, p. 9.

† Proceedings Linn. Soc. of N.S. Wales, 1911, Vol. XXXVI, Part 3, Sept. 27. "Notes on the Native Flora of N.S. Wales," Part VIII, Camden to Burragorang and Mt. Werong.

‡ *Ibid.*, p. 576 and p. 565.

Digitized by Google

The following table gives the succession of strata met with:—

I. Tertiary—Basaltic intrusions and flows.

II. Triassic—Hawkesbury Series { 1. Hawkesbury Stage. 2. Narrabeen Stage.

III. Palaeozoic—

A. Permian { 1. Upper Coal Measures. 2. Upper Marine Series.

B. Post Devonian and pre-Permian intrusions.
(*a*) Granite and (*b*) dkyes.

C. Upper Devonian—
1. Volcanic Action.
2. Contemporaneous lavas and tuffaceous sediments.
3. Quartzite, sandstone, claystones, and shale.

D. Upper Silurian slates and limestone.

(I) TERTIARY.

The rocks to which a Tertiary age has been assigned consist of relatively small exposures of basalt on the top of the Far Peak. Both are thought to represent the remnants of lava flows, although it is possible that the former is associated with a plug or dyke. A much more extensive area of basalt occurs at Mount Colong, the southerly portion of which is intrusive, but the bulk of the exposure is undoubtedly effusive. A feature of this exposure is the extensive scree of subangular fragments of basalt extending down the southern slopes of the mountain. The following petrological information regarding the Tertiary basalts is supplied by Mr. McKern.

The basalt capping the Far Peak differs from the general type of Tertiary basalt in New South Wales. The rock is a nepheline olivine basalt with plentiful olivine phenocrysts in a hard black aphanitic base.

The Mount Colong exposure is also nephelite bearing.

(II) TRIASSIC (HAWKESBURY SERIES).

(1) *Hawkesbury Stage.*

The rocks of this period are represented by beds of pebbly sandstone capping the tops of the range on the northern side of the Tonalli River and having a maximum remaining thickness there of about 300 feet. These beds are referable to the Hawkesbury Stage.

(2) *Narrabeen Stage.*

The Narrabeen Stage is represented by beds of very similar sandstones, but its upward limit is defined by beds of grey and chocolate coloured shales intercalated with thin beds of sandstone. The total thickness of this Stage under Pulpit Rock, 4 miles N.E. from Yerranderie, is about 450 feet, and it rests conformably on the Upper Coal Measures.

The sandstones forming the top line of cliffs on the Far Peak are thought to be referable to the Narrabeen Stage.

On the upper slopes of Mount Colong, 4½ miles west from Yerranderie, another exposure of the Narrabeen Stage is to be seen, resting on the Upper Coal Measures, and overlain by basaltic lava. These beds here have a thickness of about 180 feet, and as the chocolate shale horizon was identified, this probably represents the total thickness of the Stage.

Digitized by Google

At the top of Barrallier's Pass, on the western side of the basalt exposure, a small patch of sandstone occurs, which is thought to represent the remains of the Narrabeen Stage.

To form some idea of the thickening and dip of the Triassic Series towards Sydney, it may be pointed out that at the Pulpit Rock the base of the Hawkesbury Stage occurs at an altitude of 2,100 feet above sea-level, and the remaining thickness is 500 feet.

In the Sydney Harbour Collieries Shaft, distant about 56 miles in an east-north-easterly direction from the above, the base of the Hawkesbury Stage occurs at a depth of 944 feet below sea-level, and the top of the shaft, 80 feet above sea-level, is well below the top of the Stage.

This gives a thickening of probably about 1,000 feet and a dip exceeding 50 feet a mile.

The top of the Narrabeen Stage, as observed on the slopes of Mount Colong, occurs at any altiude of 3,200 feet, and the thickness is about 180 feet.

In the Sydney Harbour Collieries Shaft, about 64 miles distant from Mount Colong in an east-north-easterly direction, the top of the Stage was reached 944 feet below sea-level, and the base at 2,800 feet. This gives a thickening of 1,676 feet, and a dip of about 64 feet per mile.

(III) PALÆOZOIC.

(a) *Permian.*

(1) *Upper Coal Measures.*

These occur more or less continuously round three sides of the Yerranderie amphitheatre. On the northern side they are exposed at the base of the cliffs formed by the Hawkesbury Series (Triassic), but to the west and south they occur as a series of outliers occurring at the top of the cliff formed by the Upper Marine beds. They consist of sandstones and shales with cherty bands, and in places a coal seam has been exposed.

Sufficient evidence was not obtainable to determine whether the coal is on one horizon only. The seam is not continuous over large areas, however, as evidenced by the following. An outcrop of coal has been prospected by a tunnel near the highest point on the bridle track leading from Yerranderie to Colong Station, at an altitude of approximately 2,400 feet. The following section was obtained near the mouth of the tunnel :—

	ft.	in.
Sandstone.		
Roof of seam—Grey shale	0	4½
Coal	0	4
Band	0	0½
Coal (splinty and bituminous) with clay partings	3	3
Hard white clay shale	0	2
Very carbonaceous shale with layers of coal	0	8
	4	9½

Floor—Clay shale.

One and a half miles easterly from this outcrop, good sections of the measures are exposed on the Far Peak, but here there is an entire absence of coal or even very carbonaceous shale which might possibly indicate a coal seam horizon.

Digitized by Google

The Coal Measures have a thickness of about 150 feet on the slopes of Mount Colong, and are here protected by Triassic beds, so this may be taken as the total thickness on the western confines of the area dealt with. No appreciable thickening occurs within this area, for apparently it is very little greater under Pulpit Rock, but as traced north-east or east, beyond the confines of the accompanying map, the Upper Coal Measure strata increases in thickness.

At the Pulpit Rock the top of the Measures occurs at an altitude of 1,650 feet above sea-level, whereas at Sydney it is over 2,700 feet below sea-level, the distance being 56 miles in an east-north-easterly direction, which indicates a dip approaching 80 feet per mile in that direction.

It would appear that the prospects of locating a workable area of coal immediately adjacent to the Yerranderie Silver Field are not at all encouraging.

(2) *Upper Marine Series.*

The Upper Marine beds occupy a large portion of the area examined, and have, to a considerable extent, obscured the outcrops of the Yerranderie lodes. It is interesting to note, however, that denudation had proceeded sufficiently far to expose rich portions of the outcrop of the main lode, and thus facilitate the prospecting and development of this source of mineral wealth.

Typical Upper Marine fossils have been found in these beds in their easterly extension towards the Wollondilly River, but none were observed in the south-west, west, and north-west exposures.

From the stratigraphical continuity, and relationship to overlying and underlying formations of proved geological age, there is no reason to doubt that the unfossiliferous portion of these beds is also referable to the Upper Marine Series. The possibility of the beds being of freshwater origin in part presents itself, or it may be that conditions were unfavourable for either the existence or the preservation of marine fauna. The beds consist for the most part of gritty sandstones, with, in places, numerous boulders (up to 6 feet in diameter in the basal beds).

It appears probable that many, if not all, of these boulders represent erratics, although no striations due to ice action were observed. In places the bedding planes in the sediments immediately under some of these boulders have been quite perceptibly bent, and this is best accounted for by the boulder having been dropped from ice into soft sediments.

Plate VIII was prepared from a photograph taken by Dr. W. R. Browne, Assistant Professor of Geology at the Sydney University. This boulder is to be seen on the left-hand side of the road leading from the hotel to the Post Office, about half a mile from the hotel.

It is difficult in places to differentiate the basal beds from the disintegrated Devonian conglomerates, for most of the boulders appear to be derived from that source, and not from the direct disintegration of either pre-Devonian formations or post-Devonain intrusions.

The Upper Marine beds rest unconformably upon rocks of Devonian age, and in places cover the outcrops of the lodes, but in no case was there any indication whatever of the lode fissures extending up into them. (See page 36.)

The Series varies in thickness from about 600 feet on the western side of the area to upwards of 700 feet to the north-east, but owing to the unevenness of the floor upon which they were deposited there are great local variations.

Digitized by Google

To face page 18

[*Photo—Brown.*

A boulder of quartzite of Devonian Age embedded in basal beds of Upper Marine Series. Probably an erratic. Note bent bedding planes in underlying sediments.

Digitized by Google

Digitized by Google

The general dip is towards the north and east at a low angle, and in a distance of 20 miles in a north-easterly direction from their top on the eastern slopes of Mount Colong to the same horizon at the junction of the Cox and Wollondilly Rivers, the fall is approximately 2,700 feet, or about 135 feet per mile.

(b) POST DEVONIAN AND PRE-PERMIAN INTRUSIONS.

GRANITE AND DYKES.

(a) *Granite.*

Apart from the igneous rocks to which a Tertiary age has been assigned, two other types of intrusive rocks have been found within the area geologically surveyed.

The most important of these is the somewhat extensive exposure of aplitic granite occurring about 5 miles in an easterly direction from the Yerranderie post office, and well exposed in the bed of the Tonalli River.

That the granite is intrusive into the Devonian beds is well seen in the bluff on the left-hand bank of the river within P.M.L. 5, Parish of Terni. Here the western contact of the granite with the Devonian rocks is exposed and tongues of the intrusive mass pass irregularly into the overlying and adjacent Devonian sediments.

The latter rocks, in addition to the regional metamorphism common to the Devonian formation in this district, have been further altered and crushed, so that it is difficult to determine whether they are altered tuffs or lavas. Distinct banding dipping N. 60°W. at 61° is noticeable, and appears to indicate a sedimentary origin. This dip is abnormally steep for the Devonian rocks in the Yerranderie area, and has probably been influenced by the granite intrusion. Ascending the adjacent foothills on either bank of the river, beds of Upper Marine age occur resting on the granite, but they have not been intruded nor in any way disturbed or altered. This indicates that they were deposited upon the denuded surface of the granite.

The foregoing facts definitely restrict the geological period during which the intrusion took place, for it is clearly post-Devonian and pre-Permain in age.

It is recognised that there were a number of granite intrusions in this State during the Carboniferous period, and the writer is of the opinion that the occurrence in question is referable to that period.

Two distinct silver lodes have been located in the granite, and will be described in that portion of the report dealing with Mines (page 56).

(b) *Dykes.*

The second type of pre-Permanian intrusions occur in the form of dykes, and have been exposed only in mine workings. In the Wollondilly Mine, excellent opportunities are available for investigating one of these dykes, and a description of the occurrence is supplied.

The only other recorded instance of a similar occurrence is that of a rock from the Silver King Mine, situated about 50 chains a little south of east from the Wollondilly Mine.

This sample was submitted to the Departmental Petrologist some years ago, whilst the mine was working. Mr. McKern, late Petrologist to the Geological Survey, compared the rock and microscope slide with those from the Wollondilly Mine occurrence and found them to be identical.

Digitized by Google

The Silver King Mine has been abandoned, and the workings were full of water during the recent geological investigation of the Yerranderie field, so that the occurrence could not be examined.

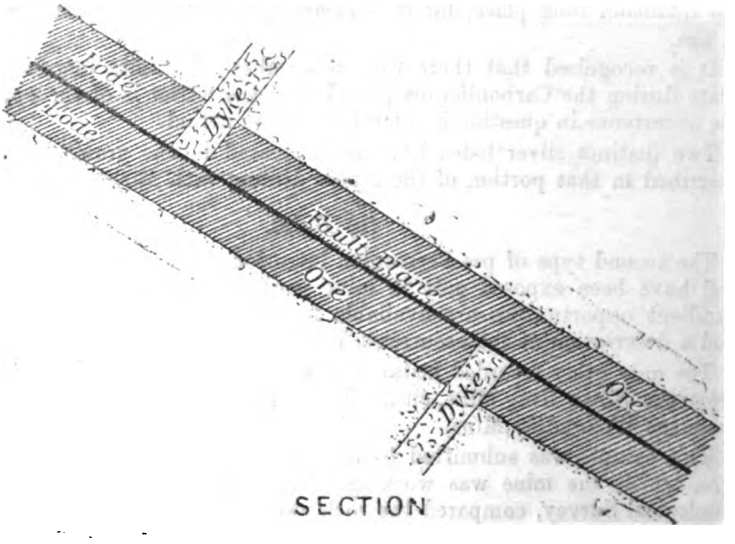
The plan of the Wollondilly Mine workings herewith shows the dyke at the various levels and through stopes. It ranges in width from 2 feet up to 4 feet 6 inches, varies in dip from nearly vertical to 70 degrees to the west, and strikes from true north and south to north 40 degrees west. This latter variation is no doubt due in part to the sinuous course of the dyke channel and also to the relative position of mine workings. It is not possible at present to measure or calculate the amount of vertical displacement owing to the absence of a distinguishing local feature common to both the hanging and footwall portions of the dyke.

The following significance is claimed by miners on the field with regard to the dyke and its relation to makes of ore. As the dyke is approached, good makes of ore always occur on one side of the dyke or the other. That is, if the ore bodies are small or of low grade on one side of the dyke, the reverse will be the case on cutting through it. The writer failed to verify this, and places no significance upon the dyke as applied to ore bodies. The makes of payable ore on this field are all separated by more or less barren zones, and moreover no dykes have been located in any of the other producing mines.

Mr. J. Gordon McKern, formerly Departmental Petrologist, describes this dyke as follows :—

Available evidence appears to point to this intrusion having post-dated the lode fissure and main formation of ore bodies, but that a limited precipitation of at least some of the lode-forming minerals was continued after the dyke intrusion.

The conditions pertaining with regard to the dyke and lode are indicated in the following sketch section :—



Digitized by Google

(c) UPPER DEVONIAN.

1. VOLCANIC ACTION.

A consideration of the general map, together with the petrological notes by Mr. McKern and Mr. Whitworth, indicates that the Yerranderie mining field is situated within a denuded volcanic area of Palæozoic age, and that the volcanic debris, which is abundant in the area, has been intruded irregularly by large masses of felsitic rock. The nature of these intrusions is not quite clear owing to the difficulty of field differentiation, but the possibility of them being in the nature of volcanic cores presents itself.

The richer portions of the Yerranderie ore deposits at present opened up appear to occur within these intrusions, and there may be some casual relation between the felsitic rock traversed and the occurrence therein of lode enrichments of a more permanent character than those found in lodes in lavas or tuffs.

Generally speaking, the field work indicates that a volcanic focus existed in the Yerranderie area because of the evident abundance of volcanic agglomerates and associated lavas. Sedimentation appears to have proceeded with the volcanic outbreaks in as much as there are many exposures of associated sediments containing abundant fragments of the volcanic ash of the district. These features are well shown in the natural exposures along the Tonalli River, the Jooriland Creek, and in other places.

2. VOLCANIC EFFUSIVE ROCKS.

Lava Flows, with patches of Volcanic Agglomerate.

Owing to regional metamorphism, the Devonian rocks in this belt of country have undergone great alteration. This renders it impossible to differentiate most of the lava flows in the field without exhaustive petrological evidence associated with careful detailed field work.

It is felt that this work would serve very little useful purpose from a mining point of view, moreover the exigencies of the State Geological Survey do not permit of such being carried out at present.

There is ample evidence in the form of beds of volcanic ash and tuff, and agglomerates, that there were a succession of flows, but in most instances macroscopic, and very often microscopic characters are so similar that differentiation is impossible. Over most of the area the beds of tuff or agglomerate separating lava flows are lenticular in character, and do not form persistent horizons, so that one flow lies in juxtaposition to a succeeding flow of a similar or identical rock type.

In view of these conditions, no attempt has been made either in the geological map or the section to individualise either the flows or horizons of pyroclastic rocks.

Probably the best section illustrating the succession of lava flows and tuff beds is to be seen in the creek bed about 10 chains south-east of the Yerranderie hotel.

The difficulties confronting the field geologists will be appreciated on examining this section, and endeavours to differentiate the intercalated lavas from the pyroclastic rocks are most disappointing in the field. (See Petrological Notes, Appendix II.)

Digitized by Google

Similar conditions pertain north of the main road, about 60 chains east of the hotel, and also east from Basin Creek, but exposures are masked by soil or talus.

The area covered by the volcanic series is considerable, and that they extend beyond the confines of the accompanying geological map is evidenced by samples of similar rock types from some miles up the Wollondilly River submitted to the Petrologist for determination.

In the neighbourhood of Jooriland Creek, in the south and south-west portion of the area mapped, only volcanic rocks were observed, and the petrological examination of the types collected points to lava flows forming the entire land surface to the exclusion of pyroclastic rocks.

Mr. Willan examined the country in the neighbourhood of Jooriland Creek, and in ascending Egan Trig. Station, which rises to about 1,000 feet above the creek level, found the section exposed to apparently consist entirely of lava, with no evidence of a succession of flows. This, in the writer's opinion, is not conclusive evidence that only one flow is represented, for it has been pointed out that frequently one flow may lie in juxtaposition to another without evidence of a succession.

Ascending the Tonalli River from the granite outcrop, lavas and pyroclastic rocks are exposed in the bed of the river for about 5 miles. An outcrop of Devonian sediments then occurs for a few chains, followed by a comparatively small exposure of the volcanic series. Above this the sediments again occupy the river bed, and continuing upstream alternating exposures of sediments and volcanics are exposed.

These conditions are due to dips and rolls, and supply evidence as to the general dip of the Devonian formations to the north, and to the presence of easterly and westerly pitching undulations.

Volcanic Agglomerates.

The agglomerates occur as isolated patches up to an acre or more in extent, associated with the lavas and apparently pyroclastic rocks, but seeing that some of the latter types consist of lava accompanied by much fragmental material, it is possible that the rocks associated with the agglomerate are all in the nature of flows.

The rock fragments and masses of which they are mainly composed consist of felsite, rhyolite, and other lava types, the size of which varies from less than half an inch up to 3 feet.

The best exposures are to be seen in the bed of the Tonalli River, just above the road crossing to Byrne's Gap; on the hill slopes on both sides of Basin Creek near its junction with the Tonalli, and crossing the road between the police station and Kerry's shaft.

The occurrence of these agglomerates is one of the few definite types of field evidence with regard to vulcanicity, and as pointed out, may be considered favourable indications of the proximity of volcanic necks.

Within the group under review are included not only the purely fragmentary volcanic series, but also those types to which a double origin may be assigned, that is rocks with a lava matrix, but containing undoubted microscopic evidence of foreign or fragmentary inclusions.

Digitized by Google

Sufficient petrological work has not yet been done in connection with this area to justify a strict classification, and field mapping is practically impossible.

Some of the tuff beds have undoubtedly been deposited under aqueous conditions, as evidenced by inclusions of well waterworn quartz and other rock pebbles, whilst other pseudo-sedimentary rocks have been proved under the microscope to consist of a lava matrix with included fragmentary rocks caught up during the period of flow.

Owing to subsequent regional metamorphism it is practically impossible to separate these types in the field, and the onus of differentiation must rest with the petrologist.

It has been pointed out that the tuff beds occur as a series of more or less isolated lenses, and no one horizon could be traced continuously.

No marine fossils were found in them, nor has there been any sorting of the material as regards the size of the contained fragments. Both of these conditions may have been due to the proximity of the volcanic vents from which the tuffs were ejected.

The dip and even strike of these beds is very difficult to obtain, the former being obscured by silicification and pronounced jointing, and the latter by reason of the difficulty of distinguishing the tuffs from the lavas in the field, and from the isolated lenticular shape of the beds.

In the creek bed referred to on page 21 a good opportunity is afforded of examining the tuffs *in situ*, and descending from the racecourse several types are exposed.

The rock occurring on the east side of the course has been described by the petrologist as a "crystal tuff with a little microspherulitic rhyolite also, as included fragments."

Macroscopically, this rock has all the appearance of a primary igneous origin, and resembles a porphyry.

Lower down the creek a bed of tuff is exposed containing water worn pebbles of quartz, &c., whilst just below this horizon a bed of fine grained dark grey material occurs, which under the microscope proved to be "a tuff crowded with broken crystals, and also containing a large piece of already consolidated tuff, which is in part rhyolitic."

The tuffs gradually die out in a northerly and westerly direction, and give place to rocks of purely sedimentary origin.

The accompanying petrological descriptions (Appendix II) supply further information regarding the tuffs, together with the locality in which they were noted.

3. ROCKS OF SEDIMENTARY ORIGIN.

The Devonian sedimentary rocks are best exposed in the immediate vicinity of the Tonalli River, and consist of conglomerates, pebbly quartzites, and silicified arenaceous clay stones.

Palæontological evidence as to the age of these beds was found in the upper reaches of the Tonalli River, and they are plentiful in an exposure 7 chains north of the north boundary of M.L. 20, Parish of Colong, but the specimens obtained were very imperfect.

Mr. Dun, Palæontologist to the Geological Survey, described the material submitted to him as "Devonian grit containing *Orthoceta*?, bivalve casts, and brachiopod impressions."

Digitized by Google

In the watershed of the Kowmung, the typical Upper Devonian fossil *Spirifera disjuncta* is plentiful, and Mr. Dun was able to definitely identify the specimens submitted to him.

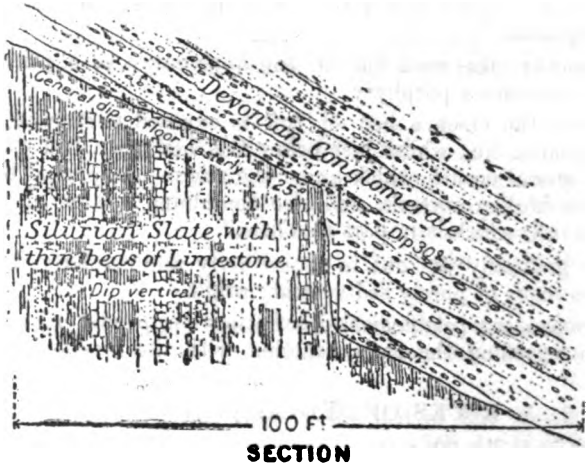
A feature in regard to these fossils is that they all show strong evidence of distortion in the form of a longitudinal thrust which has given the shell a marked asymmetrical appearance.

The northerly dip of the Devonian sediments in the valley of the Kowmung is very marked, as also are the low east and west dipping rolls. They occupy the tops only in the vicinity of the Brolga Range, but gradually descend to river level in the vicinity of Christy's Creek. Above Church Creek they are entirely absent, and the Upper Marine rocks rest directly upon the Silurian beds.

Where exposed in the Kowmung River the Devonian rocks consist of quartzites with occasional beds of conglomerate and silicified mudstones. The number of included quartz veins and "splashes" is most marked and some of the rock faces are thickly covered with the latter.

A quarter of a mile below the junction of Christy's Creek with the Kowmung River, on the left-hand bank, an excellent exposure of the junction between the Devonian and Silurian formations is to be seen. The general dip of the Devonian beds here is in a north-easterly direction at angles of inclination ranging up to 35 degrees.

Some 50 feet above the river, a bold bluff exposes the following section:—



SECTION

The irregular surface of the Silurian beds is marked, as is the unconformity between the two geological periods.

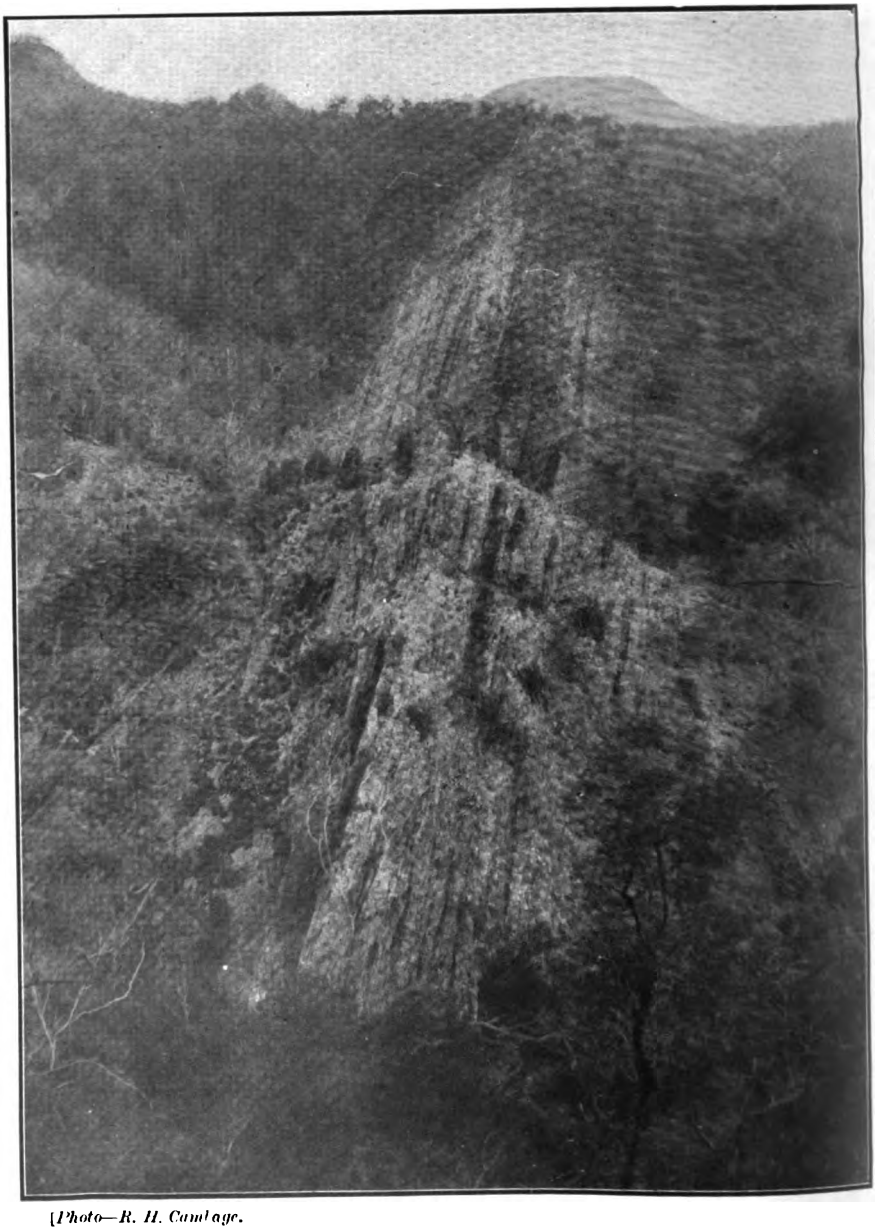
A few chains below this, the Devonian beds reach river level, and the nature of the channel becomes much more rugged, with a rock bottom and precipitous sides. It is possible to ride down the valley this far by crossing the stream from one narrow flat to another, but once the channel enters the Devonian beds, progress is difficult even on foot.

Digitized by Google

Digitized by Google

PLATE VI.

To face page 25.



[*Photo—R. H. Camlage.*

Outcrop of Silurian Beds, east side of Kowmung River, looking south, Mount Colong (basalt) in the distance.

Digitized by Google

(d) UPPER SILURIAN.

The beds referable to this geological period are not exposed in the Tonalli watershed, but they form a marked feature in that portion of the watershed of the Kowmung River included in the accompanying map.

The rocks consist for the most part of closely bedded slates, very fissile, and comparatively free from arenaceous bands. Towards the southern end of the area, a prominent belt of limestone occurs, with a length of about 5 miles, and an average width of 25 chains.

The limestone contains fossil impressions and casts, and Mr. W. S. Dun, Palæontologist to the Survey, identified the following :—

Pentamerus Knightii.

It is in this belt of limestone that the Colong Caves occur. The dip of the Silurian beds is almost vertical, but in places they underlay to the west at from 70 to 80 degrees. The northerly and southerly strike is very pronounced in all the east and west gullies running into the Kowmung, as is well seen in the accompaning plate VI, reproduced from a photograph by Mr. R. H. Cambage, late Under-Secretary for Mines.

The unconformity between the Silurian and Devonian sediments has been dealt with on page 24.

Within the area under review, quartz veins carrying a little gold have been prospected in the Silurian beds, but without success, and no silver-lead lodes have yet been located.

Digitized by Google

CHAPTER III.

STRUCTURAL (A) AND MINING (B) GEOLOGY.

FOLDING, FAULTING, LODE STRUCTURES, ORE DEPOSITION AND MINERAL ASSOCIATION.

(A) Structural Geology.

1. *Folding.*

There are at least three systems of folding within the belt of country under review.

The Triassic and Permian rocks have not been subjected to marked folding, but conform more or less generally to a gentle sagging towards the north and east. In fact, they here form the south-westerly rim of the extensive low-dipping main Triassic and Permian basin of New South Wales, the central portion of which is situated some 60 miles in an east-north-easterly direction.

The Devonian beds were warped to form the floor of the Permian basin, and folding has resulted in a series of comparatively low anticlines and synclines dipping at angles of 9 degrees to 30 degrees to the east and west.

In two or three places, particularly in the valley of the Tonalli River, the dip becomes much more accentuated, but these exceptions are probably due to local causes such as proximity to intrusive masses, namely, the Tonalli granite or the volcanic plug rocks, or to faulting.

The unconformity between the Devonian and Permian strata is well seen on many of the steep slopes falling to the Tonalli River.

The Silurian beds are characterised by the steepness of their dip, which, as a rule, is practically vertical. No acute local folding was observed, and the dip and strike are fairly uniform throughout. The marked unconformity between the Silurian and Devonian formations has been described on page 24.

2. *Faulting.*

Faulting in this belt of country is evidenced both in the field exposures and in the mine workings, and at least two periods are indicated, namely:—

1. Pre-lode fissuring in a more or less east and west direction.
2. A. Post-lode faulting coinciding in strike with 1, and identified only in the lode itself.
   B. Comparatively small faults striking diagonally across the lode channel.
3. Faults which have displaced the beds, striking in a northerly and southerly direction.

1. The fissuring which paved the way for the lode formation was probably due to adjustments after the intrusion of the Post-Devonian granite.

The nature of this fissuring has been described on page 37 (Lode Occurrences), where it is pointed out that there is still an element of doubt as to whether the main Yerranderie lode occupies one continuous fissure.

Digitized by Google

Digitized by Google

Digitized by Google

The available evidence indicates no very great vertical or horizontal displacement in the original fissuring. Had such taken place, one would expect to find evidence in places of the footwall country differing from the hanging-wall, seeing that the fractured beds are low dipping, and consist of various rock types.

Owing to the Devonian rocks being largely covered with beds of post-lode age (Upper Marine Series), opportunities for locating fissures parallel to the main lode, on the underlay side, are not available in the neighbourhood of the working mines. On the northern watershed of Basin Creek, however, several quartz outcrops have been prospected, but no defined fissures are exposed.

On the footwall side of the main fissure, a parallel fissure has been proved within the Burragorang Mine holding, Lance shaft, 140 feet north of the Burragorang shaft, having been sunk on a parallel lode. These workings have fallen in, and an examination was not possible, but the company's mine plan indicates that two small lenses of ore were stoped out.

Again, in the Tonalli granite exposure, two well-defined fissures occur, with a similar strike to the main Yerranderie fissure.

It is not often that pronounced fissuring is confined to one line, and parallel movements are to be expected.

2. A. At a later stage, after the lode was formed, probably only in part (see page 34), further movement took place, which resulted in fracturing within the lode channel. Evidence is available of at least one movement practically parallel with the original fissure, for not only are evidences of this movement to be found in the ore bodies, such as polished and grooved surfaces along a plane within the metallic sulphides, but in the Wollondilly Mine, what is in the Writer's opinion a post-lode dyke has been distinctly faulted, apparently in both a vertical and horizontal direction (see page 20). It seems possible that the foregoing displacement is attributable to a readjustment after the volcanic activity which led to the dyke intrusions.

2. B. Evidence of another type of displacement is to be seen in No. 7 level, west, Silver Peaks Mine. Here the channel is dipping at an angle of about 37 degrees, and the quartz and ore veins strike diagonally from the hanging-wall to the footwall. In the face in question (25/7/24) these veins have been faulted to the extent of about 4 feet in an easterly and westerly direction. This movement is probably a final phase of No. 2 A system of faulting, as is the fault breccia to be seen in No. 6 level west in the same mine.

3. Surface evidence of faulting is to be seen in the bed of the Tonalli River at the northern end of portion 24, parish of Terni, on the left-hand bank of the river, a little over 1½ miles north of the Yerranderie Hotel, where there is an excellent exposure of a fault.

This fault strikes 10 degrees east of north, and has a westerly dip of 57 degrees. The faulted beds consist of fine-grained quartzites and siliceous shales on the westerly side of the fault, and on the opposite side of a felsitic lava, porphyritic with quartz crystals (both of Devonian age). The amount of vertical displacement is about 100 feet.

Some 2 miles further up the river, in portion 29, parish of Terni, on the left-hand bank of the river, another small fault occurs in Devonian sediments, striking north and south, dipping vertically, and with a down throw

Digitized by Google

to the east of about 15 feet. The Upper Marine beds form the land surface some 15 chains north of the river, and here again no evidence could be found of their having been affected by the fault.

East from the Silver King Mine, near the old Great Peaks Company's shaft (P.G.L. 50, parish of The Peaks), on the main road adjoining that P.G.L., there is evidence of a fault. Here in the drainage channel on the north side of the road, the strata have been steeply tilted and apparently displaced, for beds of volcanic tuff abut against shale, with an apparent fault plane intervening. The exposure is very limited in extent, and no tangible definite evidence of faulting was noted, although the Yerranderie lode has not been traced further east on its line of strike, but some 6 chains north, on the opposite side of the assumed fault, a quartz lode carrying a little galena, iron pyrites, and zinc blende occurs, with a strike and underlay corresponding to the Yerranderie lode, of which it may be the easterly faulted extension.

In a creek some ½ mile north of the road, on the strike of the assumed fault, the beds show evidence of shearing and jointing, which are suggestive of a fault, but only lavas are exposed.

Again, on the prominent hill some 30 chains south of the assumed fault, exposed on the road, the strata are tilted and disturbed, although no displacement was positively identified.

If the occurrence referred to above is a fault, and there appears justification for that assumption, and its strike were extended to the Tonalli River, it would connect with the fault occurring in Portion 24, Parish of Terri (see page 27), and both are apparently of the same age.

Faults Proved Underground.—No traces of the foregoing faults were found in the overlying Permian rocks, and it seems probable that they antedate that period. As will be seen by the plan of the Wollondilly Mine workings, an apparent fault was intersected in four of the western levels of that mine.

As the assumed fault was approached in the various levels, the country became very soft, and the channel is filled with crushed and decomposed rock, not extending west, but abutting upon solid country rock. It was found necessary to drive about 80 feet in a northerly direction along the assumed fault plane before a defined channel was again located.

It was naturally assumed that this was a fault, but prospecting during 1926 disclosed good ore bodies in the zone of supposed faulting, and consequently the lode has been proved to be continuous, with an almost rectangular bend to the north for a distance of 80 feet, when it again swings to the west, with no continuance of the supposed fault plane in the country rock forming the footwall of the lode.

This sharp deflection is rather difficult of explanation in a true fissure vein, but the following suggestion is not opposed to available evidence. Should the east and west fissure occur in a volcanic plug rock, the boundary of which would be a circumferential curve, and not continuous in one direction, it would be quite possible for the fracturing forces to extend along the periphery for a short distance before assuming the normal strike.

In No. 3 level east from the No. 6 shaft at the Colon Peak Mine, evidence of a fault was observed in the footwall side of the level. About 80 feet from the end of this level two pronounced cross courses occur about 10 feet apart, both dipping to the south-west at angles varying from 35 to 58 degrees.

Digitized by Google

About 120 feet from the face of this level the lode is cut off by an east and west vertical fault, but the level continues on into the country with no indications of a lode or defined channel.

It is probable that the cross courses are branches of the main east-and-west fault, but the amount of displacement is apparently small.

In the Wonga Mine workings, from 80 to 100 feet off the left-hand side of the main shaft, a marked crushed zone occurs, which is referred to locally as "the fault."

This was accessible only on one level (No. 4), owing to the workings having been filled with rock waste. Here a belt of crushed country containing a quartz (mineralised in part) lode is exposed. The lode is some 2 feet wide, and dips at an angle of 47 degrees to the north. This lode was followed down practically from the surface, where it was exposed in a tunnel, and has been stoped out to the bottom level of the mine, as shown on the accompanying plan (Plan 8) over a length of 40 feet, yielding rich ore.

On levels Nos. 4 and 5, a transverse lode from a few inches up to a foot in width connects the crushed zone lode diagonally with the main lode.

According to statements made by miners, it would appear that the "fault" did not displace the main lode, but "ran into it," with a narrowing of both lodes.

As the workings were inaccessible it is inadvisable to express a definite opinion as to the nature and origin of this occurrence, but in view of the available information, it seems probable that it represents a zone of weakness filled with lode material during the formation of the main lode, and is not due to subsequent faulting. It would appear that the fissure-forming forces here operated so as to form channels in part along the pseudo-bedding planes in the lava, as more or less vertical cracks and crushed zones, and in transverse fissures connecting the above two types.

The lode-forming solutions or vapours deposited their mineral constituents in all these, but there was not enough ore material to form large continuous bodies.

On the north side of the shaft in No. 6 level, and 500 feet from it, the following occurrence was observed. A pronounced joint occurs in the hanging wall, from the main lode; here, about 1 foot wide, a vein of quartz extends up into the joint. About 25 feet further along the level, close to the face, the main lode meets another pronounced joint striking south 85 degrees west, and practically vertical. The lode material, mainly quartz, spreads up and down the joint, but apparently does not extend beyond it, thus forming a recumbent capital T-shaped occurrence.

The foregoing conditions in the Wonga Mine are referred to in this portion of the text because it is thought that they are attributable to one or other of the periods of faulting.

3. *Lode Structures.*

Sufficient evidence is not yet available to definitely correlate the Burragorang-Wollondilly lode with the Colon Peak-Silver Peaks lode, the proved east and west limits of which are now over 10,500 feet apart.

There is a gap of about 1,200 feet between the limits of the underground workings, and in this gap several lodes have been found by surface prospecting, but they have neither the strike nor dip of lodes worked in either group of mines.

Digitized by Google

Mine workings extend continuously on the fissure for about 2,560 feet in the Burragorang-Wollondilly Mines, and for 3,440 feet in the Colon Peaks Mine, about 1,200 feet of undriven on ground intervening. It has been pointed out (page 38) that the main lode in plan resembles a recumbent S shape, if continuous throughout. This is due in part to the effect of surface contour upon the outcrop of a comparatively flat dipping lode, but underground workings prove that there are also pronounced deflections in the strike. Some of the apparent deflections, however, as implied by mine workings, are due entirely to a steepening of the dip of the lode, with a consequent change of direction in the level in order to maintain the grade.

Local characteristics in either plan or section are a succession of lenses, frequently in close juxtaposition, with the pinched portions subordinate to the lenses as regards length. In other places both conditions may be equally represented. The ore lenses in the Wollondilly Mine vary in length from 3 feet up to 112 feet, with a maximum thickness of 5 feet, but more often under 2 feet.

On the other hand, in the Colon Peaks-Silver Peak Mines, the main ore lenses worked appear to have had a much greater length and in places the width between walls exceeded 40 feet.

The probability of these long lenses being composite, that is, a series of small lenses in juxtaposition, and combining to form one more or less continuous chute, is indicated by evidence still to be seen in some of the stopes and levels.

The change from a pinched portion to a lens is often comparatively abrupt, and instances were observed of the lode making from a mere thread to a thickness of over 2 feet within a height or length of 3 feet.

A study of the plans of the two main mine groups, namely, the Burragorang-Wollondilly and the Colon Peaks-Silver Peak, appears to disclose two different conditions in regard to the occurrence of "pay ore."

In the first-named group the ore bodies occur as a series of lenses close together, and individually of no great size. No consistent pitch has been proved in these lenses, for they lie at all angles from the horizontal to the vertical.

In view of the above conditions, the management contemplates the advisability of "blocking-out" practically the whole of the lode material between levels.

Mr. Hardman, the mine manager of the Wollondilly Mine, has proved also in many instances, that whilst a level, rise, or winze may pass through a barren zone a few feet, or even inches, beyond the existing workings, highly payable patches of ore may occur.

The values in this mine have been so consistent, and the ore lenses so close together, that with a very few exceptions, almost any block of lode, which may look most unpromising in levels, rises, or winzes, is worth extra mining.

The solid ore is reported to average about 6 cubic feet to the ton, and an average width of two and a half inches of ore is stated to be payable.

In the areas worked by the Colon Peaks and Silver Peak Mines, mine plans appear to indicate that the main ore bodies occur in three distinct and more isolated chutes, known as the Eastern, Central, and Western, or Duck House.

The eastern chute has not been worked to any extent, and what little stoping has been done appears to indicate that the "make" of "pay ore" was not continuous, and that it occurred in two or more isolated lenses, lying almost vertical, but with a tendency to pitch to the west.

Digitized by Google

A length of over 400 feet separates this chute from the central chute, but as development work has, up to the present, been practically confined to driving these levels through the assumed blank, it does not appear that a well-defined and isolated chute has been proved as yet.

The central chute has been stoped out over a maximum length of about 560 feet, and to a depth of about 1,200 feet on the underlay or 800 feet vertically from the outcrop.

At the present time, in the absence of mine assay plans, it is not possible to ascertain what the average values were throughout this chute, but there is reason to believe that it was of a composite character, and that it contained lenses of high grade ore, separated by patches or lenses of ore of much lower grade, and even by blanks, where the ore value was negligible.

With regard to the question of three distinct ore chutes in the Colon Peak and Silver Peak Mines, it must be recognised that Mr. A. F. Mixner, manager of the latter mine, located the rich Western or Duck House chute of ore in No. 7 level by development work based on the assumption that a permanent ore body with a more or less vertical pitch would be found.

The western chute has been worked from about 100 feet below the outcrop to a vertical depth of 800 feet below the Silver Peak shaft top. In the Colon Peaks Mine workings this chute appears to have a decided pitch to the west, but within the Silver Peak workings, apparently the same chute becomes almost vertical.

The difference in the mode of occurrence of the ore bodies in the two mine groups, that is, the close association of a series of comparatively small lenses as opposed to three apparently distinct and widely-separated chutes, may be more apparent than real.

It is possible that further "makes" of payable ore may be located by systematically prospecting the assumed barren zones. Certainly all the levels have passed through them, and in a few instances rises or winzes have penetrated the barren zones without disclosing any makes of pay ore. On the other hand, it has been proved repeatedly on the field that highly payable ore occurred a few feet above or below levels, or on both sides of a rise or winze, but not seen in either.

It is not possible to indicate the most favourable places to prospect the blanks, and to thoroughly test the lode throughout would be costly. The writer is of the opinion, however, that a prospecting campaign on these lines is fully justified. Efforts might at first be concentrated within an assumed blank zone between any two levels. If this were thoroughly tested and results were unsatisfactory, then it would be *prima facie* evidence that the ore does occur in definite chutes separated by barren zones, and mine development could proceed on specific lines.

To do this prospecting thoroughly would possibly necessitate winzing every 30 or 40 feet, and even if only comparatively small lenses of ore were located, the tests should pay, for development work (shafts and levels) has already been done.

Several instances have been proved in mine workings of the channel bifurcating and forming two bow-shaped lodes, which come together at each end, thus forming arched stringers, or "bay windows," as they are called locally.

A proved example of an arched stringer is to be seen in the Colon Peak Mine, No. 9 level west, about 214 feet from the internal shaft. The level was driven on the footwall channel, and a vein was located passing into the hanging wall. Fifty feet further on the workings disclosed a vein coming in from the hanging wall. A short crosscut was then driven into that wall, but no further veins were found.

Digitized by Google

No similar occurrences have been located in the Wollondilly Mine, but others have been seen in the Colon Peaks-Silver Peak Mines.

In the western end of the Silver Peak Mine workings, the following conditions have been proved:—

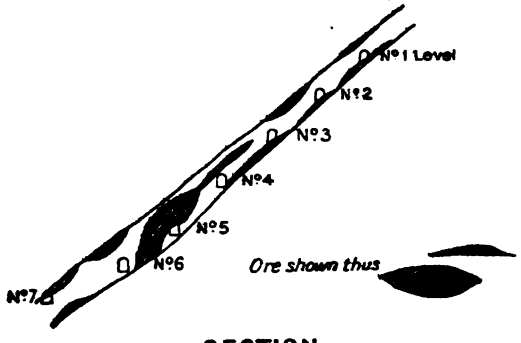
In each level, at a point about 1,000 feet west of the shaft, the channel has been proved to be up to 40 feet wide, and the ore occurs either on the footwall or the hanging wall only, on both walls, as an isolated lode in the central portion of the channel, or filling the entire width of the channel.

The occurrence is known as the Duck House or western chute, and has a length of about 270 feet. As followed in a westerly direction the walls come together again, and form a defined channel from 2 to 3 feet wide, which, in places, contains up to 8 inches of high-grade ore.

In No. 7 level the contracting of the walls is abrupt, and the hanging wall dips towards the footwall at an angle of 45 degrees at the western end of the occurrence. In the other levels the angle of separation is much more gradual, however.

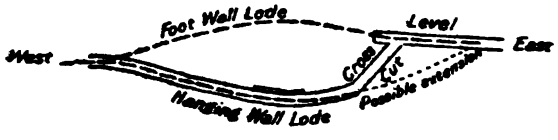
The eastern end of this occurrence has not yet been opened up sufficiently to determine whether it is lens-shaped or represents a definite forking of the channel, with the hanging wall gradually disappearing into the country.

The following sketches illustrate two possible modes of occurrence, whilst the section shows the position of ore bodies in regard to the walls:—

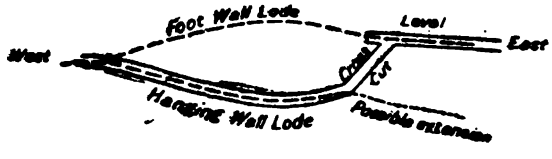


SECTION

No 1



No 2



PLAN

Digitized by Google

In the Colon Peak Mine, No. 7 level east, the west end of the Duck House chute occurs at a point 50 feet from the internal shaft. From there in an easterly direction, a similar spreading out of the walls to that in the Silver Peaks Mine takes place.

In an underhand stope 80 feet east from the shaft, a vein of ore in the central portion of the channel has been opened out, and apparently the footwall lode only has been worked in the overlying levels.

It is apparent that the material above the central vein is not country rock, for it shows no defined wall, and consists of channel material with splashes of sulphide. Moreover, the Duck House chute of ore worked is here only about 100 feet long as against 270 feet in the adjoining mine workings.

Under the circumstances it seems very desirable that the true hanging wall be located in search of ore bodies similar to those so successfully worked in the Silver Peaks Mine. A rise of under 20 feet should reach the true wall, but further prospecting along it may be necessary to expose an ore body.

In the light of the foregoing it is evident that there is in places a spreading out of the two walls, but the footwall appears to have always been followed by levels prior to the provings in the Silver Peaks Mine within the last year or two. Consequently crosscuts in search of a hanging wall channel appear to be advisable at likely looking spots in old workings. This applies particularly to the Colon Peaks Mine, in view of the provings in the Silver Peak Mine further down on the underlay of the same lode.

Another factor which presents itself is the desirability of long crosscuts into the hanging wall in search of parallel lodes. That such occur is proved in No. 2 level crosscut from the vertical shaft back to the main lode in the Silver Peak Mine, for a defined vein was cut in the hanging wall country some 20 feet further south than the main Yerranderie lode. The vein was certainly only about 6 inches thick, and consisted mainly of quartz, but it has only been opened up for a few feet, and may improve, particularly in a westerly direction where the best values are known to occur in the main lode.

The possibility of this being the easterly extension of the western chute hanging wall lode presents itself, but there is no evidence available upon which to base an opinion.

The hanging wall country is covered with rocks of Upper Marine age, so that surface indications of a lode are obscured, consequently crosscuts would be the best means of prospecting.

The walls of the lode on this field are, as a rule, smooth and flat in one plane, and in many places hundreds of square feet have been exposed, showing a smooth, uniform surface. The ore is separated from the walls by a flucan or clay parting of varying thickness, and it is very rare to find the ore "frozen on" to the walls, which are striated or polished in places. The underlay of the lodes varies from 25 degrees up to 40 degrees, with occasionally a marked local steepening.

In places the angular value of the dip of the lode is approximately uniform. Thus the shaft on the lode at the Wollondilly Mine maintains a grade of 30 degrees on the footwall of the lode to a depth of 1,400 feet, from which depth the daylight at the mouth of the shaft may be seen. Corrugations in the walls, however, are not uncommon, as, for example, in No. 11 level east of the Wollondilly Mine shaft, where a typical set of corrugations has been exposed by mining operations. Here the hanging wall shows a series of ridges and depressions about 4 feet from centre to centre, with a 6-inch "spring."

Digitized by Google

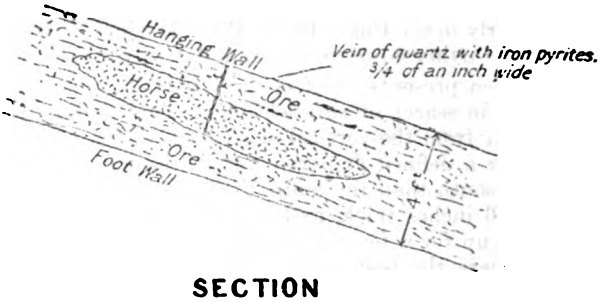
4. *Ore Deposition.*

The ore deposition of the Yerranderie field appears to be due to the permeation of heated gaseous emanations and watery solutions mainly of magmatic origin.

These probably represented the final phases of the Tonalli granite intrusion, for as pointed out elsewhere, lodes similar in every respect to the Yerranderie lodes occur in that granite, thus proving their age to post-date the actual intrusion.

Evidences of more than one period of lode formation are to be found in most of the mine workings. These consist of ore bodies parallel with the walls, diagonal to the walls, irregular-shaped makes of ore transgressing the banded ore, and quartz and mineral veins (mainly iron pyrites) intersecting the main lode.

A good example of the latter was exposed in a stope off No. 8 level west, Colon Peaks Mine. At a point about 200 feet west of the shaft, in an underhand stope, the following section was exposed:—



SECTION

The ore consisted of laminated quartz, veined with galena, iron pyrites, zinc blende, &c., containing isolated blebs of quartz, and in other places of massive banded sulphides, with small makes of isolated quartz, themselves containing isolated patches of sulphide.

A good instance of replacement of the country by ore was observed in the hanging wall of No. 11 level west, Wollondilly Mine, 100 feet west of the fault. Here a small tongue of the sulphides has eaten its way into the hanging wall for about 6 inches in height and 2 feet in length, partially replacing the country rock.

Thin veinlets of ore up to a quarter of an inch in thickness occasionally occur in either the hanging wall or the footwall, running parallel with the main lode, and a few inches from it. Lensing of the ore bodies, as distinct from a similar structure in the lode channel is characteristic throughout all the mines. A good example was noted in No. 6 level west, Silver Peak Mine, about 1,000 feet from the shaft. Here, whilst the channel maintains a width of 4 feet, a make of ore starts as a mere thread, on the footwall, and within 6 feet reaches a thickness of 2 feet, when it again closes up.

A pronounced feature with regard to the ore bodies is the abrupt change which takes place in the mineral constituents. Massive galena may give place to iron or arsenical pyrites, zinc blende, quartz, or even country rock.

Digitized by Google

within a few inches. This factor, when taken in conjunction with the pronounced tendency to form lenses in both the ore bodies and the channel itself renders it very difficult to estimate ore reserves, even in a block of ground which may be exposed on four sides.

No consistency could be observed in the relation of these changes, and the method of formation of the lodes, &c., was not ascertained. Similar conditions pertain in all the mines, and occur irrespective of depth.

5. *Mineral Association.*

The distribution of ores in fissure lodes is almost invariably unequal, and it is difficult to assign a reason. A careful study of local conditions may lead to an approximation of the governing factors, but, "unfortunately, up to the present, no certain method of doing this has been found."*

Consistency in the grouping of minerals in lodes is not characteristic, and exceptions may be as numerous as rules. This was very noticeable on the Yerranderie field, and the following conditions appear to have different significations in different mines.

Silica.—In the Wollondilly Mine, the presence of much quartz in the lode material is considered favourable for the occurrence of good ore in the immediate vicinity. In the Colon Peaks and Silver Peak Mines, the presence of quartz either has no significance, or is considered unfavourable, but channel material only between the walls is likely to give place to good ore bodies at any time.

Zinc blende in the Wollondilly ore generally indicates higher silver values, but in the case of the other two mines the reverse is claimed.

Iron pyrites in the Wollondilly ore is a sign of lower silver but higher gold content, whilst in the Colon Peaks ore, the presence of iron pyrites means higher silver, but no change in gold.

In the Silver Peak Mine no significance is attached to the presence of pyrites.

Carbonate of Iron has no great significance as regards values, but whilst it is mainly in an amorphous form in the Colon Peaks and Silver Peak Mines, the crystalline form is more common in the Wollondilly Mine.

Copper is not marked in the Wollondilly ore (averages .8 per cent.), and does not appear to influence the silver or gold content. In the Colon Peaks ore it is considered favourable to higher silver values, and averages over 1 per cent. in the ore treated. Practically no copper has been noticed in the Silver Peak Mine. Bunches of bornite occur in the lode off the bottom level in the Wonga Mine.

Cerussite (carbonate of lead).—A fair percentage of cerussite appears to have been won from the Colon Peaks Mine down to No. 6 level (about 400 feet on the underlay). Large bunches of this ore were also mined in the Silver Peak Mine from No. 5 level, 800 feet from the surface. No record is available of cerussite having occurred above No. 18 level in the Wollondilly Mine, but in March, 1925, a large make of cerussite was being mined between Nos. 18 and 19 levels west, with a proved length of 90 feet, and up to 3 feet wide. The bulk of this ore contained about 100 ounces of silver and 27 per cent. lead per ton, and small flakes of native silver were occasionally detected.

* A Treatise on Ore Deposits, by J. A. Phillips and Henry Louis, p. 93. London, 1896.

Digitized by Google

Arsenic has been found in all the mines, the content ranging from half a per cent. up to 4 per cent. Between Nos. 6 and 7 levels west, Silver Peak Mine, the arsenic increased very much, however, and may go up to nearly 20 per cent.

The presence of arsenic does not appear to influence values, but entails a penalty in smelting charges of 3s. per ton of ore for every unit over 2 per cent.

(B) Economic Geology.

The economic geology of the Yerranderie field is closely associated with the interpretation placed upon available evidence, which is often far from satisfactory, and further confirmation is desirable.

In the past, mining geologists who inspected the field appear to have accepted without question the idea that the lodes all occur in a post-Devonian intrusion of porphyry.

The presence of an extensive volcanic series has now been definitely established, and the existence of contemporaneous volcanic plug rocks of Devonian age appears to be indicated. This necessitates, on the writer's part, a modification of the views previously held, and throws considerable light upon the nature of the lode types found on the field. Confirmatory evidence on many points is still wanting, however, and until this is forthcoming the writer's present views must be considered as more or less tentative.

The outcrops of the lodes are not prominent, and are hidden in many places by the overlying Upper Marine beds. This renders it impossible to trace the outcrops of the lodes continuously, or to establish definitely their relationship one to another except by mining methods.

The minerals recorded in this report as occurring in the Yerranderie lodes is no doubt an incomplete record, as collecting has only been incidental to the work of mine examination over a limited period, and a more detailed study of the lode might enable the list of minerals to be extended.

Types of Occurrences.

Within the Yerranderie field there is an entire absence of lode formations in rocks of Permian age. It is possible on this field to trace many of the lodes for a considerable distance in rocks of Devonian age, and they are found in a post-Devonian intrusion, but never extend upwards into rocks of Permian age.

This factor is well illustrated in the westerly extension of the main Yerranderie lode, for following the outcrop in a westerly direction from Bartlett's main shaft the upper marine beds extend over the strike of the lode, and there is no evidence of their having being subjected to lode forming influences.

The absence of lode formations in rocks of late Palaeozoic age in the southern and eastern parts of Australia has been discussed by Mr. E. C. Andrews, Government Geologist of New South Wales.*

Mr. Andrews points out that "No folding movement of note has taken place in Australia since the Palaeozoic, and no ore deposits younger than the Palaeozoic have been recorded from the continent."

* Economic Geology, vol. xviii, January-February, 1923, p. 6.

Digitized by Google

Further, "That the ore deposits of the Australasian region were formed during periods of folding, and further, that the ore deposits are related intimately to igneous emanations."*

Mr. Andrews attributes the absence of lode formations in the younger Palaeozoic rocks south of the Hunter River largely to the absence of folding, whilst on the other hand the same writer claims that—†

> "The ore deposits of central and southern New South Wales appear to belong to two periods at least, namely, the Ordovician and the closing Devonian."

There is indubitable proof that the Yerranderie ore bodies occur in Devonian rocks, and in a post-Devonian intrusion, thus they must be of post-Devonian age, with apparently a lengthy chronological break between their formation and Devonian sedimentation.

Occurrences and Genesis of Lodes.

Available evidence points to at least three types of lode occurrences on the Yerranderie field, namely:—

(*a*) Fissure veins with a more or less easterly and westerly strike.

(*b*) Fissure veins in part, with an approximately northerly and southerly strike, and in places passing into pseudo-bedded veins.

(*c*) Pseudo-bedded veins in the lavas and tufts.

(*a*) The lodes of the first-mentioned type are by far the most important, and have probably yielded 90 per cent. of the ore won on the field. The Burragorang-Wollondilly lode is an excellent example, the strike of which is persistent over a length of nearly 2,000 feet, with a consistent average underlay of 30 degrees to the south to a depth of 1,448 feet, or to a vertical depth from the shaft mouth of 700 feet.

Mine workings prove that beyond the 2,000 feet limit, in both an easterly and westerly direction, the channel has a decided swing to the south.

Similar conditions are found in the Bartlett-Silver Peak lode, which has an east and west strike for over 1,200 feet in the lower levels, and an average underlay of 30 degrees, but steepening to 42 degrees below No. 8 level. The underlay of the lode within the above mines is more variable than that proved in the Burragorang-Wollondilly mines, the variation in strike at the extremities proved is more pronounced and to the north instead of to the south.

For instance, in the lower eastern levels, Colon Peaks mine, the lode underlays up to from 60 to 70 degrees from the horizontal, and the strike swings round to approximately north-east and south-west.

On the western side of the shaft the lode persists for a greater distance in an easterly and westerly direction, and the dip maintains its average, but No. 8, the most westerly level on the channel, swings more to the north, and at the extreme end is within 10 degrees of the meridian.

The identity of these two lodes on one continuous channel has not yet been definitely proved, for not only is the extreme westerly working of the Wollondilly mine about 1,200 feet distant from Bartlett's most easterly workings, but the possible continuity of the outcrop is obscured by a

* Economic Geology, vol. xviii, January–February, 1923, p. 9.
† *Ibid*, p. 7.

Digitized by Google

covering of the rocks of Upper Marine age. These, as pointed out, did not participate in the lode-forming conditions, and consequently afford no evidence on the question.

The strike of the lode would need to have changed its direction by 45 degrees approximately within a distance of 700 yards if continuous throughout.

Mine plans, together with a traverse round the outcrop as determined by shafts, trenches, &c. (see plan 5), indicate that the fissure, if continuous, resembles in plan a deformed recumbent S shape.

It is well known that a vein or lode may possess pronounced changes in strike, particularly if it traverses marked differences in rock structures.

On the other hand, this marked sinuosity is not common in a true fissure vein, and other factors, such as the occurrence of a number of fissures practically at right angles to the main east and west lodes where they are not deflected, is in the writer's opinion suggestive of a change in the physical structure of the fractured rocks, and a dissemination of the fracturing forces, with corresponding reduction in the size and frequency of ore bodies.

It has been pointed out in the portion of this report dealing with Devonian vulcanicity that there may be areas of rock which represent plugs in Devonian volcanic vents.

The main east and west lodes occur in this rock type, judging by the microscopic determination of rock samples collected from outside the zone of alteration due to the formation of the lodes. Samples from well over 100 feet from the lode (Silver Peaks mine, crosscut from shaft, No. 2 level) are too altered, however, to afford much information.

The northerly and southerly striking lodes seen on the surface are either in lavas or pyroclastic rocks, which are comparatively easy of differentiation.

Mine workings indicate that the east and west lodes, if opened up far enough by levels, change their strike to a marked degree. The deflection is not abrupt, but the channel as followed gradually swings round to the north or south.

Owing to the great alteration the country rock has undergone in the vicinity of the lode, differentiation was not found possible as regards the rock type confining the east and west or north and south lodes.

Owing to the alteration of the country rock it is not possible to differentiate rock types in the vicinity of the lodes underground, but in the field the northerly and southerly striking lodes are largely associated with pyroclastic and effusive rock types.

The Writer has formed the opinion that the east and west lodes are associated more or less with rocks representing the plugs of Devonian volcanic vents. Tangible evidence in support of this opinion is not available, however, and the explanation must remain in doubt.

(*b*) Fissure veins in part with an approximately northerly and southerly strike, and in places passing into pseudo-bedded veins.

Lodes classified under the above heading are particularly hard to differentiate, and appear to merge into other types. In this connection it would be helpful to refer to the letterpress on page 27, where the evidence of post lode movement is discussed. The writer recognises that this secondary movement may have accounted for the formation of some, if not all, of the lode types now under review.

Digitized by Google

The most favourable area in which to study the above type of lode occurrence is on the south side of the Tonalli River, between the river and the Yerranderie Post Office, within P.M.L. 49 and P.M.L. 8.

Surface prospecting within P.M.L. 49 has proved the occurrence of several lodes striking in some cases at right angles to the normal strike of the main lode, and in others at an angle of about 45 degrees from the payable portion of that lode.

The dips of these lodes vary considerably both in direction and angle of underlay, as will be seen on reference to plan.

The available evidence points to at least some of these lodes being saddle-shaped, and possibly occurring in pseudo-bedding planes in the lavas, or true bedding planes in the tuffs. These exist in the form of east and west dipping rolls, with a general pitch to the north.

During 1925 prospecting on the western portion of the Wollondilly mine leases resulted in the exposure of a low arched saddle-shaped lode, with one "leg" pitching to the west and the other to the east.

Values were patchy, and the lode small, so that work was abandoned. In no case has this type of lode been found to contain large or permanent ore bodies, the lode material consisting mainly of quartz, with comparatively small makes of silver-lead ore. In some instances these were certainly very rich—for instance, from the St. George mine, long since abandoned, one small parcel is said to have assayed as high as 1,200 oz. of silver per ton.

(*c*) Pseudo-bedded veins in the lavas and tuffs.

The most favourable locality for examining this type of lode is on the south side of the Tonalli River, within P.G.L. 51, parish of The Peaks, about half a mile north-west of the Yerranderie Post Office.

Here, on a spur extending to the river, four distinct inverted saddle-shaped lodes are exposed, and have been opened up in part. Each has a pitch to the north, and on the eastern side of the hill the dips are to the west at angles of from 20 to 30 degrees, whilst on the opposite side the dips are to the east, at similar angles. In each case the dip has been observed to flatten out as followed down. One of these lodes has been prospected by means of underlay shafts from either side of the spur, directly opposite one another, and about 10 chains apart. In the lower portion of the western shaft the lode has been found to lie practically horizontally, and in the eastern shaft the flattening is well evidenced.

The outcrop of these lodes, as followed from one side of the hill to the other, are bow-shaped in form, with the arcs of the bows extending south, and lying one behind the other. This is due to surface contour, and to the dip and pitch of the lodes themselves, which vary in width from a few inches up to 2 feet.

The lode material is mainly quartz, with galena and iron pyrites sparsely disseminated. The country rock consists of lavas. A few bags of prill ore have been won, but the probability of any tonnage of pay ore occurring here is, in the writer's opinion, very remote.

There are other localities where this type of lode appears to occur, but the evidence is not so conclusive. Amongst these may be mentioned P.M.L. 35, Parish The Peaks, 3 miles east of Yerranderie. Here we have quartz lodes containing galena, &c., associated with volcanic tuffs. Also the Feldsworth, on P.M.L's. 47 and 48, Parish The Peaks. The lode varies in width, and is composed of quartz with galena, carbonate of iron, and iron pyrites, &c.

Digitized by Google

Largely owing to the limited amount of capital invested, and the richness of the ore won, excellent returns have been obtained by the comparatively few investors, but in view of the returns for the past twenty-five years, it is hardly to be expected that there will be a big increase in the future output, although the field promises to produce payable ore for some years to come, even under present conditions.

The mines actually producing ore during the period in which the field was under observation by the writer (April, 1923 to June, 1925) were four in number. No order of precedent as regards productivity can be given, for each has had its highly satisfactory periods, as well as periods of depression.

The four producing mines were the Colon Peaks, Silver Peak, Wollondilly (formerly Yerranderie) and Wonga (formerly Tonalli).

Mining conditions are good throughout the field, and very little timbering is required, whilst there is no trouble with water underground except in shaft sinking, and even then the seepage is not excessive. The levels are a good height, dry, and exceptionally well ventilated, but naturally at long dead-ends the temperature is higher, and it takes longer for the air to clear after firing.

Mine timber and firewood are plentiful, and as a rule sufficient water is conserved in dams or obtained from underground to meet all mining requirements.

DESCRIPTION OF INDIVIDUAL MINES.

The main east and west vein systems—

1. The Colon Peaks, or "Bartlett's."
2. The Silver Peak, or Bore Block.
3. The Wollondilly.

Other lines of lode—

4. The Wonga.
5. The Burragorang.
6. The Great Western, or Nevada.
7. The Silver King.
8. Coffey's Prospecting Area.
9. Piece of Pork.
10. St. George.
11. The Feldsworth.
12. Myall Ridge.
13. Silver Star, or Terni Lodes.
14. The Great Peak.

During the year 1926, the following areas were held under mining lease:—

	acres.	roods.	perches.
J. V. Bartlett	179	0	17
Colon Peaks Mining Co.	56	3	30
Silver Peak Mines, Ltd.	297	2	25¼
Wollondilly Silver Mining Co.	117	1	27
Wonga Silver Mines	41	2	21
Nevada Syndicate	40	0	0
Messrs. Norris and Brough	20	0	0
The Terni Syndicate	133	0	20
F. B. Brown (Machinery area)	2	0	0
	887	3	29¼

Digitized by Google

The Colon Peaks, or Bartlett's Mine.

This mine was practically the first to start production, and from the year 1898 to 1923 has produced, according to Mr. J. V. Bartlett, who was the pioneer and holds a majority of the shares in the company, well over £600,000 worth of bullion.

Since 1923 the annual production has been much reduced, but there is every probability that the mine is only passing through one of the lean periods common to every mine on the field. The vigorous development policy now being pursued appears to be fully justified, and should lead to an increased output.

The mine workings consist of four external shafts, namely:—Main shaft, 464 feet deep, underlay 30 degrees at top, 36 degrees at bottom. No. 6 shaft, approximately 700 feet deep. The new shaft 580 feet deep, all on the underlay, and a vertical shaft near the western boundary of P.G.L.I., 200 feet deep, connecting with No. 8 level (internal shaft). A shallow shaft was also sunk about 110 feet east of the main shaft, penetrating to a depth of 120 feet.

The internal shaft starts from No. 6 level, about 1,050 feet west from the main shaft, and is at present 510 feet deep on the underlay (32 degrees average). It is intended to continue sinking this shaft to the lease boundary, a further distance of 240 feet approximately. The levels driven at the time of going to press were numbered from 1 to 11, their total length approximating 15,000 feet.

The stoped ground is indicated on plan at end, which points to three separate chutes of ore having been worked. These are referred to respectively as the Eastern, Central and Western, or Duck House chutes. Very little stoping has been done on the East chute (No. 6 shaft), and it has not been located in the lower levels, the amount of development work being limited. The Silver Peak mine, adjoining on the underlay, has not yet driven far enough east to reach the assumed position of this chute should it be continuous.

Its absence in existing workings may be due to—

1. The chute is not continuous in depth, but represents a more or less isolated ore body.
2. The eastern levels have got off the strike of the lode.
3. The chutes of ore here resemble those in the Wollondilly mine, and are more or less isolated by blank zones through which the levels passed. (Note on plan at end the isolation of No. 7 level east stope.)

Until further work has been done on the channel in the form of driving, rising and winzing, and possibly by cross cutting, it is not possible to express a definite opinion on this portion of the company's leases. Certainly, further prospecting appears to be justified, seeing that the shaft is already sunk, and that the ore stoped was of high grade, particularly the block near the eastern end of No. 7 level.

The Central chute has been stoped out from the surface down to No. 6 level (main shaft), and has yielded a large tonnage of good grade ore.

Apparently No. 7 level passed through this chute in a barren zone, for no stoping has been done between No. 6 and No. 7 levels, On the other hand, the chute has been stoped out on its underlay in the adjoining mine right down to No. 8 level, but values appear to have been patchy. This point is worth considering in conjunction with the opinion expressed on page 31, that the existence of three well-defined chutes may be more apparent than real, and that levels may have passed through barren zones.

Digitized by Google

The Western or Duckhouse Chute may be defined, for descriptive purposes, as the ore bodies occurring between the apex of the hanging and foot wall "spread" (see page 32), and extending back east up to 270 feet from that apex. The ore bodies west from the apex are also included in the western chute by the mines staff, however, although they are separated from the main body by a blank zone in the lower levels.

This chute has apparently been stoped out from No. 1 level down to No. 10, and stoping is now going on in No. 11 east. An examination of the mine plan indicates that the western chute is continuous from the Colon Peaks No. 1 level, right through to No. 7 level, Silver Peak mine (not yet reached in No. 8 level), a distance of nearly 900 feet on the underlay.

In the Colon Peaks mine a considerable body of ore has been stoped out west from where the channel has assumed its normal width of from 1 to 4 feet (*i.e.*, the apex of the "spread"). Up to the present the hanging wall side of "spread" has not been prospected within the Colon Peaks mine, but the provings on the underlay in the Silver Peak mine have been so very successful that prospecting by means of rises from the footwall is essential in several levels.

It appears advisable to do this at two or more points from 100 to 200 feet east of the "spread" apex, and in at least two levels, for the ore bodies are unlikely to be continuous throughout, as witness the provings in the Silver Peak mine. (See page 45.)

The value of the prill ore from this mine may be gathered from the following smelting returns kindly furnished by Mr. J. V. Bartlett:—

COLON PEAKS MINING COMPANY (NO-LIABILITY)—RETURNS.

ORE.

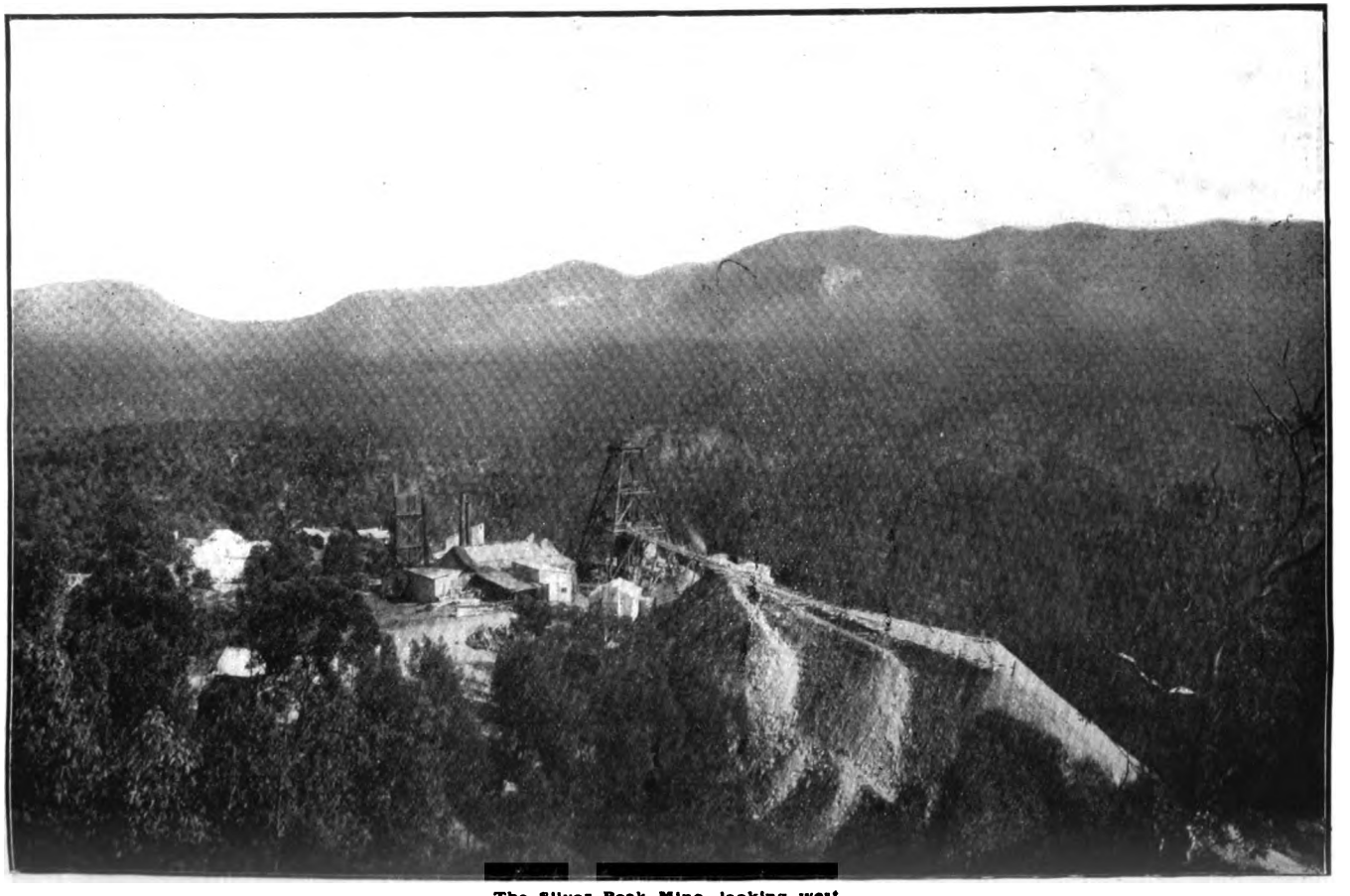
Year.	Tonnage.	Values realised per ton.			Year.	Tonnage.	Values realised per ton.		
		Gold.	Silver.	Lead			Gold.	Silver.	Lead.
		dwt. grs.	oz.	%			oz.	oz.	%
1921	82·59	3 18	214·4	42·8	1922	12·18	·1675	122·85	35·05
,,	84·77	3 18	230·1	41·6	,,	15·76	·1675	122·85	35·05
,,	85·07	3 12	278·7	42·9	,,	38·13	·1675	123·85	33·95
,,	83·37	5 21	130·9	22·5	,,	60·91	·1675	117·40	32·3
,,	75·28	3 6	84·0	24·7	,,	66·12	·1675	117·9	32·2
,,	67·74	3 6	92·0	25·9					
,,	62·77	3 12	102·0	27·9	1923	80·45	·185	118·92	31·5
,,	84·53	2 12	102·1	33·7	,,	78·22	·190	114·35	32·05
,,	66·83	2 12	88·6	38·1	,,	59·19	·175	122·63	35·35
					,,	96·10	·1875	120·15	30·10
1922	32·47	2 6	104·4	50·0	,,	61·19	·185	124·6	29·35
,,	58·83	2 3	99·2	45·4	,,	60·59	·195	130·7	28·7
,,	65·41	2 12	97·7	39·7	,,	68·25	·175	107·95	32·55
,,	56·91	2 12	93·0	40·5	,,	68·52	·175	112·4	33·3
,,	63·61	2 12	97·7	42·3	,,	94·08	·16	103·2	36·05
,,	60·60	2 6	106·2	45·4	,,	84·56	·16	103·65	30·35
,,	83·22	2 18	106·8	41·5	,,	15·63	·16	120·635	30·6
,,	75·77	3 0	112·0	35·9	,,	80·13	·15	129·0	34·15
,,	79·54	3 0	114·2	41·2	,,	44·68	·165	119·3	31·25
		oz.			,,	62·24	·18	118·25	29·5
,,	16·22	·1635	124·3	38·45	,,	63·32	·16	100·35	31·45
,,	32·90	·1635	124·3	38·45	,,	47·45	·21	96·4	29·95

Digitized by Google

Digitized by Google

PLATE X.

To face page 45.



The Silver Peak Mine, looking west.

Digitized by Google

The seconds equal about one-fifth of the total tonnage of ore raised, and are subjected to concentration in the company's own mill adjacent to the mine, the plant consisting of a Ball mill, May jig, and concentrating table, with a capacity of 50 tons per week of forty-eight hours.

The concentrates average about 1 ton from 6 tons of ore, according to the manager, and have an average value as under:—

CONCENTRATES.

Year.	Tonnage.	Values realised per ton.			Year.	Tonnage.	Values realised per ton.		
		Gold.	Silver.	Lead.			Gold.	Silver.	Lead.
		dwt. grs.	oz.	%			oz.	oz.	%
1921	55·71	4 0	147·6	34·5	1923	1·41	·20	105·2	30·9
1922	63·84	4 0	100·0	29·1	„	63·23	·20	106·3	29·2
„	77·53	3 18	104·5	31·1	„	53·70	·195	97·05	29·45
		oz.			„	48·36	·196	106·5	34·15
„	59·20	·2125	112·2	34·5	„	12·10	·196	106·5	34·15
„	61·80	·2125	110·3	34·25	„	41·17	·18	97·85	30·55
1923	2·19	·225	109·2	33·2	„	32·12	·20	76·55	27·05
„	82·72	·205	103·75	31·85					

The mine is equipped with a suction gas plant of 75 horse-power, and five boilers totalling 138 horse-power capacity, with all necessary plant for working a mine of this class.

The cost of winning and bagging ore ranges between £4 and £5 per ton, and at the present time the mine employs from forty to fifty men.

The Silver Peak Mine.

This mine adjoins the Colon Peaks mine on the south, and is working the same lode on its underlay.

The present company commenced operations in 1904, and since that date, up to the end of June, 1924, practically £325,000 worth of bullion has been produced.

A vertical shaft was sunk to a depth of 564 feet in the hanging wall country, and the lode cut at that depth. Two crosscuts were driven back to the lode at the 440 and 500 feet levels, and short drives extended along the lode either way. Good ore was won on the western side of the crosscuts from what is apparently a continuation of the central chute worked in the adjoining Colon Peak mine.

From near the foot of the vertical shaft an internal shaft was sunk to a depth of 560 feet on the underlay of the lode, here ranging from 30 to 42 degrees. Levels have been driven at about 80 feet intervals, and whilst those to the east are comparatively short, six of the western levels extend practically to the company's boundary, and in two instances connect with workings in the Colon Peaks mine.

The total length of levels approximates 9,000 feet.

Only the central chute was at first worked, and low to medium returns obtained below No. 4 level.

Digitized by Google

The company pushed on with development work, however, and subsequent to 1916 the western, or Duckhouse, chute has been located, and yielded very satisfactory returns.

It was under the present management that the presence of a hanging as well as a footwall lode was proved in this portion of the Yerranderie lode (see page 32), a development of the greatest importance as far as production has been concerned.

Since the year 1922 the output has increased enormously, all the ore having been won from the western chute, the production from June, 1922, to the end of June, 1924, being valued at over £95,000. Stoping has been carried on in all the levels from No. 7 up to the company's boundary, and whilst as far back as August, 1917, before the western chute had been opened up, the manager reported to his directors that it was likely to contain at least 18,000 tons of ore, 16,000 tons have been subsequently taken out, and the manager estimates that there are 12,000 tons of ore still in sight (June, 1925).

No. 8 level has not penetrated far enough west to reach the western chute, but as the ore body is strongly developed underfoot in No. 7 level, it appears probable that a further large tonnage of ore will be available.

In view of the existence of an eastern chute, as proved in the adjoining Colon Peaks mine, the extension of the easterly levels appears to be justified. Not only is there a possibility of this chute persisting in depth, but rich isolated lenses of ore similar to that proved above the No. 6 level in the Colon Peaks mine may also be found.

As regards the probable persistence of payable ore bodies to a depth, the available evidence appears to be favourable. The ore is just as good, if not better, in No. 7 level as it was near the outcrop, and that level is over 1,000 feet down on the underlay.

Certainly mineral associations will vary, but that is common throughout the field, both horizontally and on the dip of the lode. The bottom level at the Wollondilly mine is 1,448 feet down on the underlay, yet good ore was obtained there, and ruby silver ore was probably more plentiful than has been found elsewhere on the field.

Another point which should be again referred to here is the advisability of thoroughly prospecting the assumed blank ground between recognised chutes, even although no ore is seen in the levels.

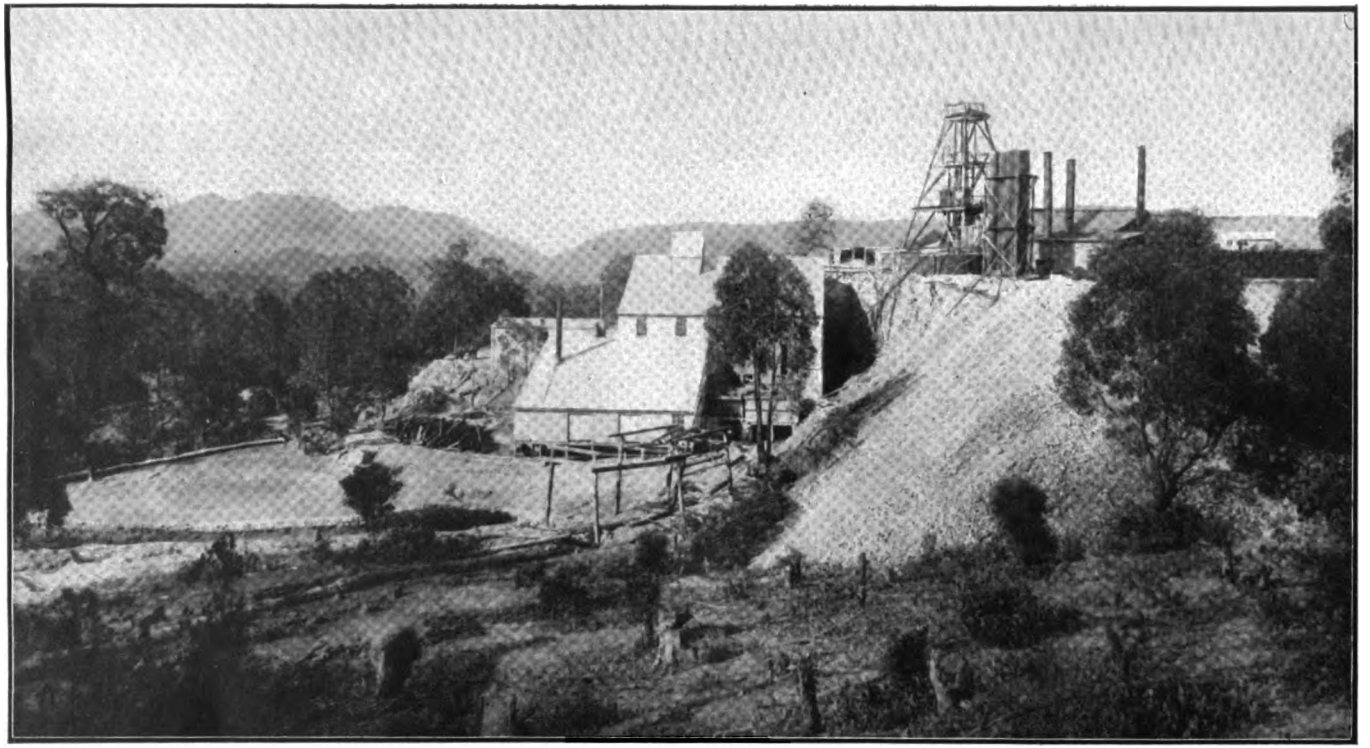
The mine is equipped with an excellent plant, the condition of which does credit to the management.

Three multitubular boilers, with a total capacity of 300 horse-power, provide the necessary power, with a Robey winding engine at the surface, and a winch driven by steam at the internal shaft. Fifty tons of material can be handled per shift, in addition to which two air compressors are driven, and also the milling plant when required, the capacity of which is from 30 to 40 tons per shift.

The milling plant consists of a rock-breaker, one set of rolls, a jig, and two concentrating tables.

Digitized by Google

To face page 48



The Silver Peak Mine.

Digitized by Google

To face page 47.

Digitized by Google

The ore is hand-picked on the ore floor, the "firsts" being bagged and despatched per motor lorry to Camden, from 14 to 17 bags of ore going to the ton. It is estimated that from 50 to 60 per cent. of the ore won may be classed as "firsts," but the "seconds" might really be classed as low-grade "firsts," and there is practically no large tonnage of low-grade ore worked throughout the field, owing to selective mining being the guiding principle. The above statements may be inferred from the following returns for the four years from June, 1921, to June, 1924, kindly supplied by the company. Comparison may be made with similar returns furnished by other companies. (See pages 44, 49.)

Years.	Tons of Ore.	Tons of concentrates.	Yields per ton.		
			Gold.	Silver.	Lead.
			dwts. grs.	ozs.	Per cent.
30 June, 1921	1,278	...	5 0	85	15
	...	40	4 23	60·2	19·8
30 June, 1922	993	...	4 0	94	31
	...	345	6 6	61·3	21·15
30 June, 1923	2,139½	...	4 0	101	32
	...	578	3 12	96	30
30 June, 1924	2,470	...	4 0	103	29
	...	531¼	4 0	76	24

The recovery from the mill ranges from 60 to 70 per cent. of the assay value, it having been proved that a higher concentration is not so profitable owing to increased costs. The unrecovered metals are mainly in the slimes, which assay from 10 oz. to 18 oz. of silver per ton and from 1½ to 3½ per cent. of lead.

The costs of winning and bagging the ore range from £4 to £6 per ton, and the following account sales, kindly supplied by the company, afford a good guide as to the value of the ore:—

ANNUAL RETURNS, SILVER PEAK MINES, LTD.

Year.	Cash Value.	Year.	Cash Value.
	£ s. d.		£ s. d.
1906	753 5 0	1917	2,510 10 5
1907	6,438 6 8	1918	14,274 9 1
1908	19,695 16 8	1919	20,148 9 9
1909	19,777 14 11	1920	20,881 5 0
1910	22,755 4 2	1921	8,555 7 4
1911	21,295 12 6	1922	16,321 0 7
1912	20,732 19 3	1923	40,467 6 7
1913	17,146 6 3	1924	54,707 4 2
1914	12,309 7 3		
1915	3,850 9 7		£323,964 9 3
1916	1,343 14 1		

From sixty to seventy men are employed, and the output averaged about 240 tons per month during 1924-1925.

Digitized by Google

The Wollondilly Mine.

This mine was formerly owned and worked by the Yerranderie Silver Mining Company, who are reported to have recovered £250,000 worth of bullion during the period they operated (from 1901 to 1922).

The present company purchased the property in 1923, and whilst the lode had been opened up to a depth of 1,448 feet on the underlay, which is 30 degrees (693.5 feet vertically below the collar of the shaft), and nearly 20,000 feet of levels driven, there still remains many hundreds of feet of solid ground between levels.

This ground appears to have been left unworked because the levels penetrated barren zones, but by systematic prospecting it has been proved that isolated lenses of high grade ore may occur within a few feet of the levels.

As pointed out elsewhere in this publication, there does not appear to be any systematic arrangement of the ore bodies into defined chutes, which would be a guide in development work, and payable ore may occur in the lode in any unworked block, although surrounded by levels and winzes in barren ground.

No defined spurs or bays have been located, the levels, of which there are 24, are all consistent in strike, and extend on either side of the shaft for hundreds of feet, at about 60 feet intervals.

Connection has been made with the adjoining Burragorang mine workings on the east, and ventilation is exceptionally good. At the west end, beyond the misnamed fault, the channel has a swing to the south in No. 12 level west, but in No. 24 level west, although it extends a little further west, no alteration has taken place in the general strike, and the northerly trend of that level is accounted for by it having reached the previously assumed fault zone.

Practically no stoping has been done from No. 23 and No. 24 levels, and there is a considerable length of lode opened up below No. 19 level not yet stoped. In view of the company's provings in the upper levels, which were thought to have been worked out, all this ground should be worth thoroughly prospecting.

A good lens of ore was being stoped in April, 1925, at the western end of No. 19 level, and was extending beyond the face, as well as both up and down, so there is reason to expect a large tonnage of ore from that portion of the mine.

Only four levels have been driven on the lode west from the misnamed fault line, and in each case an ore body was found, so that further prospecting appears to be justified in that direction in other levels, particularly the lower ones.

The ore is hand-picked underground, and the "firsts," which amount to 50 per cent. of the ore won, are bagged and sold to Sydney ore buyers.

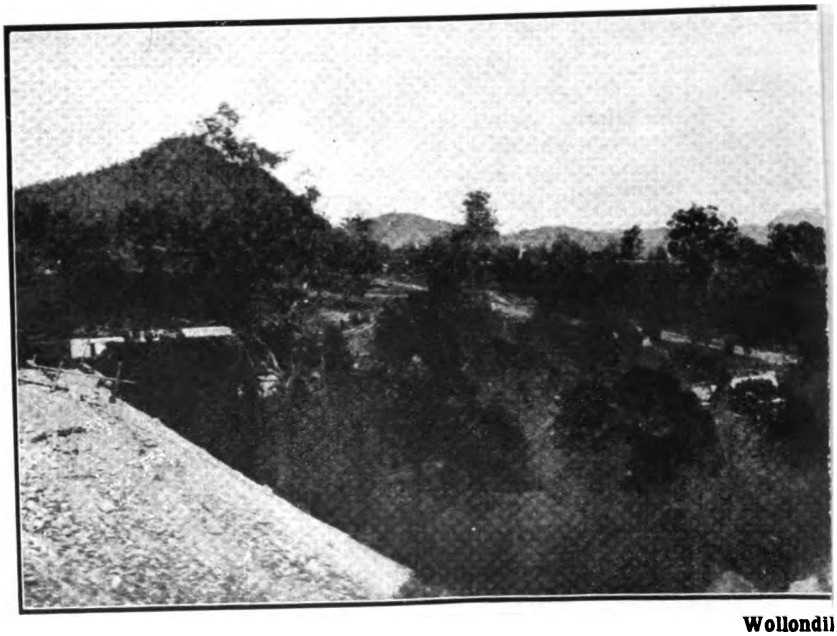
The "seconds" are crushed and concentrated in the company's own mill, which comprises a rock breaker, set of rolls, trommel, set of May jigs (three compartment), and two Wilfley tables, with a capacity of 20 tons per shift. The recovery from the mill ranges from 65 to 70 per cent. of the assay value, and costs are about £1 per ton.

The average grade of the concentrates is approximately as under:—

Gold per ton, 7 dwts. 14 grs.; silver per ton, 77.3 oz.; lead, 16.41 per cent.

Digitized by Google

PLATE XIII.



Wollondil

Digitized by Google

PLATE XIV.

Digitized by Google

The output from the mine varies, as will be gathered from the following particulars as per account sales, kindly supplied by the company.

Wollondilly Mine.

Date.	Tons.	Yields per ton.		
		Gold.	Silver.	Lead.
Ore.				
		dwt. gr.	oz.	%
11 June, 1921	28·3557	6 0	117·1	19·9
15 July, „	28·4545	5 18	111·6	19·5
23 „ „	21·0865	6 0	110·0	18·7
7 Sept., „	34·2461	5 5	96·1	21·3
24 „ „	13·9689	4 2	95·8	25·3
29 Oct., „	14·0994	4 23	96·1	24·1
20 Dec., „	7·9961	5 13	121·2	12·0 (30% Zinc).
3 Jan., 1922	10·0110	4 4	137·5	33·5
18 „ „	8·1683	4 0	136·5	33·5
	6·3306	5 14	155·6	9·2 (36% Zinc).
9 Mar., 1922	10·4648	4 12	131·5	38·1
11 „ „	14·0852	5 14	110·2	25·3
13 „ „	10·6345	3 20	132·1	38·5
30 „ „	5·9800	7 10	241·9	30·8 (17% Zinc).
5 April, „	18·9758	4 0	108·4	36·1
7 „ „	17,2387	3 22	118·6	28·0
1 May, „	19·6472	4 4	127·6	35·7
15 „ „	9·5737	4 2	115·7	28·2
27 „ „	10·0317	4 10	104·3	27·3
9 June, „	6·9817	4 0	93·5	29·1
22 „ „	14·0174	5 12	114·8	24·2
11 Oct., „	7·0998	6 5	147·6	22·0
20 Sept., „	6,9200	4 4	161·825	32·9
9 Oct., „	14·8900	4 4	111·6	25·35
6 „ „	11·9900	4 4	119·05	28·725
13 Nov., „	6,5400	4 4	127·3	22·7
13 „ „	2·2900	4 4	127·3	22·7
30 Jan., 1923	16·4000	5 0	142·6	25·45
29 „ „	23·9500	5 14	162·0	21·9
26 Feb., „	16·4400	5 4	145·85	29·2
6 April, „	1·83	4 19	141·55	24·75
Concentrates.				
9 May, 1921	21·1753	8 4	77·5	16·7
10 Aug., „	26·5843	8 18	74·0	18·1
11 Nov., „	21·0109	6 17	68·5	20·0
11 Mar., 1922	6,7230	7 0	75·5	17·3
9 „ „	27·0859	6 22	69·0	17·6
30 June, „	19·5198	8 0	85·4	19·9
22 Sept., „	19·3700	7 0	82·2	19·7
13 Nov., „	5·9300	7 19	72·55	16·825
13 „ „	9·8100	7 19	72·55	16·825
6 April, 1923	19·9600	8 0	95·80	20·9

Analyses of the ore show that it contains from 0.6 to 3.29 per cent. of arsenic, 0.2 to 0.7 per cent. of antimony, and from nil to 36 per cent. of zinc, but rarely over 15 per cent.

Digitized by Google

The Wonga Mine.

This mine was formerly owned and worked by the new Burragorang Company, in conjunction with the Burragorang mine, although the two mines are over half a mile apart, and working entirely different lodes.

The lode upon which the Wonga mine shaft was sunk has been worked by different individuals and companies, and one miner is reported to have recovered several thousand pounds' worth of ore from the upper workings.

The present company took the mine over during 1922, together with the Burragorang mine leases, and removed the plant from that mine to the Wonga mine. The plant consists of a 75 horse-power boiler, an air compressor and winding engine, with a pumping plant driven by compressed air. The lode was first prospected by means of a tunnel, and a limited tonnage of payable ore obtained. A shaft was then sunk on the underlay of the lode, which varies somewhat, as will be seen by the cross section on plan at end, but averages about 18 degrees, with a decided flattening in the lower levels, of which there are a total of nine.

The depth of the shaft is 850 feet on the underlay, and stoping is at present (1925) being done from No. 9 level, and driving No. 10 level south has been commenced.

A make of high grade ore, two inches thick, on the south side of what is known as the "Fault Line" zone (see page 29), was being stoped in April, 1925, and it was expected to cut this make on the underlay in No. 10 level south.

It has already been demonstrated in the stope that the ore may pinch out in a foot or two, and it may require considerable prospecting to locate another make.

The bulk of the ore obtained from this mine has been won from the "Fault Line" zone, but apparently there was never any large continuous body, and the lenses on the north side of the shaft are small and disseminated at irregular intervals.

There are still belts of unprospected ground adjacent to the shaft, which may contain lenses of ore, but if the writer's interpretation of the nature of the occurrence be correct, ore bodies are likely to be widely disseminated and limited in size.

The output of ore from this mine for the past 12 months (1924-5) has averaged about 4 tons per week, but no account sales are available.

The Burragorang Mine.

This mine has also changed hands several times since it was first opened up in 1911, and as it was not working during the writer's presence on the field (it closed down in 1922), an examination of the workings could not be made.

It is estimated by the secretary of the present company, that fully £100,000 worth of bullion was recovered, but detailed returns are not available.

Three shafts were sunk, the main Burragorang shaft being 1,175 feet deep on the underlay of the Yerranderie lode, with an average underlay of about 28 degrees a little to the west of south, and about 1,800 feet of levels driven, but very little stoping done.

Digitized by Google

Digitized by Google

PLATE XV.

Digitized by Google

Lance shaft was sunk on a footwall lode some 80 feet north of the main lode, but only a little over 200 feet of levels were driven, and two small bunches of ore stoped out.

Kerry's shaft is close to the main road from the police station to "Newtown," and is about 700 feet deep on the underlay of a lode dipping at about 25 degrees south, 12 east, and about 1,360 feet of levels were driven, the lode being from 1 foot to 18 inches wide.

The identity of this lode with the main Yerranderie lode is questioned by men who should be in a position to know, but as the workings have not been joined up with those on the main lode, and it is not possible to trace the outcrop owing to talus and dump heaps, the writer is not in a position to express an opinion.

Some of the ore was very rich, and bulk parcels were sent away which yielded over 200 ozs. of silver per ton, 40 per cent. of lead, and 5 dwts of gold to the ton.

The Burragorang company which worked this mine got into financial difficulties during the war period, and the mine was abandoned, but, in view of the past returns, further development work appears fully justified. Even if this were confined in the first instance to prospecting the ground between existing levels, further bunches of high-grade ore may be located, and this would provide funds for opening up new ground.

The Lance shaft lode is one of the few proved instances of a parallel fissure vein, and further prospecting on it appears to be justified, seeing that two lenses of rich ore were worked in the limited amount of ground opened up.

The Great Western or Peaks Mine.

The Great Western, or Peaks silver mine, was opened up in 1900, and during the period in which the leases were worked by that company six shafts were put down, totalling about 1,300 feet of sinking. The main shaft is 700 feet on an underlay of 35 degrees to the S. 65 W. in a defined channel up to 6 feet wide. From the bottom of this shaft a crosscut was driven back into the footwall country for 300 feet, and three channels proved, but values were not encouraging. Altogether over 2,000 feet of levels and crosscuts were driven, but only a limited amount of stoping was done. From the level on the eastern lode 200 tons of ore were recovered, which yielded about 90 oz. of silver per ton and between 35 and 40 per cent. of lead, but this appears to have been an isolated bunch, for no further makes of pay ore were located. In addition to the lavas and volcanic tuffs penetrated in the workings, at a depth of 700 feet, a level off the main shaft passed through a bed of conglomerate (Devonian?), as evidenced by samples shown to the writer. The lode appears to have cut out at the 700 feet level, d, according to the ex-manager, there was evidence of a "fault" or floor ping west at 12 degrees. This occurrence was followed for 300 feet on its derlay, and driven on for over 400 feet in a north and south direction, hilst a crosscut was driven for 100 feet into the footwall, but no further makes of ore were located.

Although it was not possible to examine these workings, the available evidence points to the makes of ore or lode material having occurred between lava flows and beds of volcanic tuff or ash, or Devonian conglomerates.

Digitized by Google

A sample of each from the dumps were identified as the hanging and foot-walls respectively.

The "fault" or floor proved by the crosscut at the 700 feet level, the three channels cut, and the bed of conglomerate, would all indicate that in this locality the lode-forming solutions and vapours had found their way between successive rock formations, and that no true fissure vein occurs.

The company ceased operations in 1919, nearly £20,000 having been spent, and only £4,000 worth of bullion recovered.

In 1922 a small local syndicate, called the Nevada, was formed to further prospect this area. Two shafts have been sunk and several levels and crosscuts driven on lode formations containing silver-lead ore in small, widely disseminated bunches, but results have been very disappointing.

If the writer's interpretation of the conditions in this area be correct, the occurrence of any large continuous body of pay ore is not to be expected, and the cost of locating the small isolated bunches is likely to exceed the value of the ore recovered.

Coffey's Prospecting Area.

Some 15 chains north-west of the Nevada lease, an area was prospected during 1912-1914 by Mr. P. Coffey by means of the diamond drill and a shaft.

Three bores were put down in the position indicated on the accompanying plan, and the provings are given in the following extract*:—

P. COFFEY'S BORES, YERRANDERIE, TO 31ST DECEMBER, 1912.

†No. 1 Bore.	ft.	in.
Shaft sunk	12	0
Boulders and gravel	6	0
Porphyry and gravel	7	0
Porphyry	3	0
Coarse gravel	2	0
Porphyry	16	0
Soft and broken porphyry	7	0
Soft porphyry goes to silt	14	0
Porphyry	15	0
Porphyry, very broken	69	0
Porphyry	23	0
Porphyry, very broken	18	0
Porphyry	2	0
Quartz Leader carrying little Ore	0	6
Porphyry	20	6
Porphyry, very broken	15	0
Porphyry	7	0
Porphyry, very broken	11	0
Porphyry	7	0
Porphyry, very broken	11	0
Very soft porphyry	24	0
Porphyry	4	0
Soft porphyry	8	0
Porphyry	1	0
Soft gravel	3	0
	306	0

No. 2 Bore.	ft.	in.
Shaft	4	0
Boulders and clay	2	0
Boulders and gravel	2	0
Gravel	4	0
Broken porphyry	24	0
Broken porphyry and boulders	3	0
Broken porphyry	23	0
Hard and broken porphyry	11	0
Broken porphyry	4	0
Hard and broken porphyry	4	0
Hard porphyry	13	0
Broken porphyry	39	0
Porphyry	17	0
Very hard porphyry	14	0
Hard porphyry	6	0
Porphyry	10	0
Porphyry with little veins of Galena	2	0
Porphyry	8	0
	190	0

* Annual Report Dept. of Mines, Sydney, 1912, p. 73, and 1913, p. 76.
† This bore was commenced with a diameter of 1¾ inches, but owing to the soft nature of strata it was found necessary to ream after a depth of 287 feet had been reached.

Digitized by Google

COFFEY'S BORE, YERRANDERIE.

No. 2 Bore.	ft.	in.
Depth bored, 1912	190	0
Porphyry	3	0
Hard broken porphyry	8	0
Broken porphyry	2	0
Very hard broken porphyry	3	0
Hard broken porphyry	9	0
Broken porphyry	2	0
Hard broken porphyry	14	0
Hard porphyry	7	0
Hard broken porphyry	4	0
Porphyry	17	0
Very broken porphyry	2	0
Porphyry	9	0
Broken porphyry	4	0
Loose porphyry	7	0
Hard porphyry	3	0
Soft porphyry	7	0
Porphyry	23	0
Hard porphyry	7	0
Broken and hard porphyry	4	0
Hard porphyry	19	0
Hard broken porphyry	4	0
Porphyry	2	0
Chocolate-coloured ironstone	24	0
Porphyry	15	0
Soft porphyry	5	0
Hard porphyry	6	0
Broken porphyry	20	0
Hard porphyry	15	0
Hard broken porphyry	4	0
Porphyry	11	0
Very soft porphyry	10	0
Soft porphyry	2	0
Very soft porphyry	2	0
Soft porphyry	1	0
Total	465	0

No. 3 Bore.	ft.	in.
Soft porphyry	6	0
Broken porphyry	24	0
Porphyry	6	0
Broken porphyry	7	0
Hard porphyry	7	0
Soft porphyry	7	0
Porphyry with galena stains	6	0
Hard porphyry	7	0
Porphyry	22	0
Porphyry with galena stains	6	0
Porphyry	19	0
Broken porphyry	17	0
Porphyry	7	0
Lode formation with quartz	3	2
Porphyry with galena, 8 inches of dark rock, and 1 foot of rock carrying a lot of pyrites.		
Porphyry	27	10
Quartz and galena	2	3
Porphyry	7	0
Quartz	0	0½
Porphyry	0	2½
Very hard porphyry	12	6
Hard porphyry	2	0
Hard quartz porphyry	13	0
Hard porphyry	26	0
Total	235	0

The bores and shaft all started in Devonian sediments, but soon entered into "porphyry," according to the record of strata penetrated.

Several horizons carrying a little galena were passed through in the bores, and in view of all the evidence available the writer is inclined to the belief that these represent the limited precipitation of lode material in bedding planes between lavas and pyroclastic rocks.

A vertical shaft was subsequently sunk adjacent to the bores, but no payable ore bodies were located.

The depth of the shaft was 170 feet, but the extent of any underground prospecting work could not be ascertained, as the property has been abandoned for some years. According to information available the lode (very small) strikes north and south.

The writer is of the opinion that prospecting in this locality, in the absence of any evidence of a true fissure vein, is likely to result in only small isolated makes of ore being located, and costs will probably greatly exceed returns if prospecting is continued.

Digitized by Google

Piece of Pork Mine (Messrs. Norris and Brough).

This prospecting area is situated on the right-hand bank of the Tonalli River below the road-crossing from Yerranderie to Burns' Gap. Here several prospecting shafts and a tunnel have been driven on what are apparently pseudo-bedded makes of quartz between lava flows, containing bunches of galena and a little iron pyrites.

Only a few bags of medium grade ore have been picked out, and the nature of the occurrences, in the writer's opinion, is not promising. Work was still being carried on from the tunnel during 1925.

St. George Mine.

This was worked at the time the Colon Peaks mine first started, and a main underlay shaft was sunk on a lode striking north and south, and dipping to the west at an angle of 17 degrees.

The mine has been long since abandoned and details as to the actual work done are not available.

The country rock is lava, and at the outcrop about 1 foot of lode material occurs between well-defined walls. It is reported that about £800 worth of ore was recovered, and that a sample from a small patch of ore assayed 1,200 oz. of silver to the ton. The area is now held by the Colon Peaks Company, but prospects are not considered sufficiently encouraging to justify further prospecting.

The Silver King Mine.

This property lies due east from the police station, and a company was formed about the year 1900 to carry on development work.

In an easterly direction from the Burragorang Mine, prospecting by means of shallow shafts and trenches appears to indicate that the main Yerranderie lode is more or less continuous in this direction right up to the Great Peak Company's shaft.

The company ceased operations in 1912, and no mine plan or detailed information as to the work done underground could be obtained. A main shaft was sunk on the lode to a depth of 857 feet, with an underlay of about 20 degrees, in a direction of 7 degrees west of south. Levels were driven, mainly to the east, but particulars regarding them or the stoped ground could not be ascertained.

Several other shafts were sunk, and tunnels driven (see plan 10), but no extensive makes of pay ore were located. It is claimed that some £10,000 worth of ore was recovered from the company's workings in this area, but the money was all put back into development work.

The dump material shows that mine workings penetrated lavas, tuffs, volcanic ash, and black slaty rock, proving that in this area the country rock differs from that found in the principal producing mines. Moreover the marked swing in the strike of the lode towards the south is also at variance with conditions in the most productive portions of the Yarranderie lode.

The present holders are prospecting some 5 chains west of the main shaft, and are driving an old tunnel into the hill, on a lode dipping at an angle of 25 degrees in a southerly direction. Occasional small patches of ore containing galena and cerussite have been cut, but they are very limited in thickness and size.

Digitized by Google

Two shafts were sunk in the north-east corner of P.M.L. 12, some 15 chains from the Silver King shaft, and a little silver-lead ore obtained. It is reported locally that 7 tons of ore from one of these shafts was treated and yielded at the rate of 29 oz. of gold per ton. The writer obtained a sample from the stope where this ore is stated to have occurred, and the assay return showed only a trace of gold and very little silver.

Such a phenomenal yield of gold is quite at variance with results obtained anywhere else on the field, and confirmation appears very desirable before spending further money in a search for payable gold.

The Great Peak Mine.

This property is situated about half a mile east of the Yerranderie Hotel, and the main shaft is adjacent to the road to Camden. Apparently it was taken up about 1906, and the shaft sunk on the underlay of a quartz vein, at an angle of about 31 degrees, 20 degrees west of south. The depth of the shaft is stated to be between 700 and 800 feet, with one short level driven about 160 feet in a westerly direction.

The dump contains similar rock types to those found in the Silver King dumps, but no payable ore appears to have been obtained, and it is questionable whether any large bodies can be expected in this area in view of the geological conditions pertaining.

On the hill to the north-east of the foregoing, a few shallow trenches have been sunk on makes of quartz containing a little galena and iron pyrites, but apparently there was not sufficient inducement to continue prospecting.

Early in 1925 a party of miners were opening up a similar occurrence about half a mile further east, but in the writer's opinion conditions are not favourable for the occurrence of large makes of payable ore.

The Feldsworth Mine.

This property is situated about 20 chains east of Basin Creek, and north from the Camden-road. It is here that the first discovery of galena appears to have been made on the Yerranderie field, but the find was not worked to any extent until 1914. At that period it was known as Dun's Mine, and the writer was informed that £3,000 worth of ore was recovered in twelve months, and that 8 tons of ore gave a return of £1,000. The main shaft is claimed to have been sunk to a depth of about 500 feet, and is on a lode dipping 10 degrees north of west, at an angle of 32 degrees, whilst another shaft in the vinicity was sunk on a lode dipping 15 degrees north of west at an angle of 12 degrees.

In both shafts the country rock penetrated consists of fine-grained lava, volcanic ash, and tuff, judging from the evidence in the levels it was possible to examine down to 180 feet. The ore occurred in small isolated bunches. No work has been done here for some years, and in view of the rock types in which the lodes occur, the writer inclines to the opinion that whilst a lucky prospector might strike a rich patch, the property is unlikely to justify heavy capitalisation.

Myall Ridge Mine.

Some three-quarters of a mile east of the foregoing, a claim known as the Myall Ridge was prospected some years ago. Here a channel up to 6 feet wide, containing quartz with a little galena, striking north and south in Devonian lavas was sunk on to a depth of 80 feet vertically. Values were negligible, and work was abandoned.

Digitized by Google

All the evidence on the Yerranderie Field points to north and south lodes associated with lavas or pyroclastic rocks, containing only small isolated bunches of ore, and prospects are not encouraging in this locality in view of the available evidence,

The Silver Star Lodes, called The Terni Mine in 1925.

These lodes are situated within portion 8, parish of Terni, on the left-hand bank of the Tonalli River, about 5 miles east from the Yerranderie post office.

Two well-defined lodes have been located in the granite intrusion, and opened up by shallow shafts and trenches. The most northerly occurrence (referred to here as No. 1 lode) has been traced for a length of about 200 feet, has an east and west strike, underlays south at about 71 degrees, and is 5 feet wide, between well-defined walls.

The lode material consists of white quartz with galena and carbonate of iron, also a little iron pyrites and zinc blende.

No. 2 lode is about 10 chains to the south of No. 1, has the same strike and direction of dip, but is somewhat irregular in underlay which appears to range from between 50 and 70 degrees.

The shaft on the underlay was full of water, and the width of the lode could not be ascertained. The material on the dump was very similar to that obtained from No. 1 lode. The occurrence of these lodes in a rock to which a Carboniferous age may be assigned is interesting and affords good evidence as to the period during which the Yerranderie lodes were formed.

The mineral constituents of the lodes in the granite are the same as occur in the main Yerranderie lodes. Their strike also corresponds closely, and whilst the dip is steeper, sufficient work has not yet been done to enable the average underlay to be determined. A steeper dip, however, might be accounted for by the nature of the country rock being different. Whilst dealing with the lodes in this portion of the Yerranderie field, one factor appears deserving of mention. The lodes have been prospected only on the high ground, and no attempt made to trace them under the flats on the east and west sides of the ridge.

The easterly extension is first obscured by a capping of Upper Marine rocks, and the granite further east is overlain by shed material and alluvium, and no lode outcrops occur

Similar conditions pertain over the surface along the possible westerly extension of the lodes.

It has been the experience of mining on the Yerranderie field that wide siliceous portions of the lodes are low grade. Such a type of lode would resist weathering, and possibly have a bearing on surface contour, i.e., would tend to form a ridge.

The ore bodies where sulphides predominate are more susceptible to weathering, and thus favourable to the formation of depressions. The deduction to be drawn from the foregoing is that the depressions along the strike of a lode are likely to overlie the less siliceous and inferentially richer portions of that lode. This is not necessarily the invariable rule, and other governing factors may give rise to numerous exceptions. It appears, however, to be a sufficiently reasonable assumption to justify a thorough prospecting of depressions along the strike of a well-defined lode.

Digitized by Google

In the writer's opinion the lower lying ground to the east and west of the outcrops under review is well worthy of prospecting by means of trenches or shallow open cuts to bedrock. As pointed out elsewhere in this publication, it is considered that the genesis of the Yerranderie lodes is closely associated with the final phases of the granite intrusion.

The generally accepted views with regard to the conditions controlling precipitation is given on page 34, and on the grounds that the temperature would be too high for precipitation in the immediate vicinity of the granite, may appear to discount the probability of ore bodies being formed there.

It must be remembered, however, that, in regard to the lodes under review, they are true fissure veins, with slickensided walls, and this implies solidification with accompanying loss of heat in the granite itself.

The subsequent lode filling vapours and solution would be at a high temperature on leaving the parent magma basin, but would surely be cooling off as they ascended the fissure veins in the consolidated granite. Consequently conditions for precipitation would become favourable, and the deposition of ore bodies in the fissure veins might be expected.

That such was the case is indicated by the presence in the Silver Star lodes of minerals common to the main Yerranderie lodes.

In view of the above the writer is of the opinion that further prospecting along the line of strike of the Silver Star lodes is fully justified.

FUTURE PROSPECTS.

It has been shown that the main east-west line (or lines) of lode has been formed by the entry of minerals into a displacement fracture. Enrichments appear to have been formed as replacements and impregnations at places on the one hand where tributary veins and cross joints take off from and intersect the main "fissure," and on the other hand at places where the country rock characteristics were favourable to the deposition of the silver-lead minerals.

It will be necessary to keep development work well ahead of actual stoping so as to have a continuous supply of ore. Unless this policy of development and prospecting be maintained, there is serious possibility of the actual ore reserves of an individual mine being depleted.

Ore Reserves.—Apart from the Wollondilly Mine workings, very little development work by sinking has been carried out on this field. Certainly upper levels have been driven on the lode channel for hundreds of feet, but in many cases they passed through poor zones, and the intermediate ground between levels was not prospected by rises or winzes.

Shafts, as a rule, only extend a few feet below a level from which ore bodies have been practically stoped out. Under these conditions only a limited tonnage of actual ore reserves can be said to have been proved, and none of the mines can claim that they have proved ore reserves which will last even two years at their present rate of output.

On the other hand, the past history of the field would indicate that probable reserves are likely to be large, for the lodes are persistent at a depth, and the ore bodies maintain their metallic values.

This is evidenced in the deepest workings on the field (Wollondilly Mine, 1,448 feet on the underlay).

Digitized by Google

Under the existing conditions it would be too speculative to offer any opinion as to the actual tonnage of ore reserves, but the field has every prospect of continuing to be a producer for many years to come.

In the case of the Colon Peaks Mine, the area held on the underlay of the main workings is limited, and deeper sinking is not likely to greatly increase ore reserves. Prospecting the hanging wall country from the No. 7 level upwards appears to be fully justified in view of the satisfactory results obtained by doing so in the adjoining (on underlay) Silver Peak Mine.

In the case of Silver Peak, it is advisable to continue sinking, and extend lower levels in a westerly direction. This will open up at least two shoots of ore, the values in which appear to be going down.

The Wollondilly Mine would be advised to unwater the lower levels, and extend those driven east, and at the same time prospect the ground between the lower western levels already driven.

Digitized by Google

APPENDIX I.

Report on Colong Caves.

Geological Branch, 9th May, 1899.

Sir,

In accordance with your instructions, I have the honor to report on the limestone caves, near Burragorang.

They are situated—

34 miles in a direct line W.S.W. from Camden;
23 miles in a direct line S.S.E. from Jenolan;
33 miles in a direct line S.S.W. from Wentworth Falls;

from any of which localities they may be reached by more or less circuitous routes.

The belt of limestone in which they occur lies between the Colong Range and the Kowmung River, and is marked here and there by more or less precipitous gorges, through which tributaries of the Kowmung River find their way.

The limestone outcrops more or less continuously for 5 miles, in a direction a little to the east of north from Lannigan's Creek to Church Creek, and is from ¼ to ½ a mile in width.

Caves occur at intervals throughout the whole length of the limestone. I beg to suggest that they be called the Colong Caves, after Mount Colong, a conspicuous landmark in the vicinity. This name is derived from the native word "Colung," signifying the home of the bandicoot.

The caves are known to some local residents as Bindook, the native word for a made waterhole.

The best known route to them is from Camden. From thence a good driving road passes through the pretty village of The Oaks, and rises gradually to the summit of Mount Burragorang, some 1,800 feet above sea level. A descent of some 1,500 feet is then made down a well-formed zigzag road. The views from this road are magnificent. On either side are mural precipices of Hawkesbury sandstone. Below lies the fertile Burragorang Valley, dotted here and there by farms and homesteads on the banks of the Wollondilly and Nattai Rivers.

The Burragorang Post Office and store is reached halfway down the mountain side. Twelve miles further on, in the valley, is the hamlet of Upper Burragorang, where accommodation is available. The visitor may then either drive a further 12 miles to the The Peaks mining settlement, from which a rough bridle track passes main caves, or a somewhat shorter route may be taken on horseback. By the latter the caves are reached in about 16 miles from Upper Burragorang, a total distance of 50 miles from Camden. At about 3 miles from the main caves the track passes over a saddle in the range on the northern side of Mount Colong, and the limestone bluffs of Lannigan's Creek are reached at a height of about 1,600 feet above sea level.

It is here that the main caves are situated, about 9 chains S.E. of marked tree (broad-arrow over P3). These consist of the Colong, or Key, Onslow, and Lannigan's Caves. The Key Cave has two entrances from the cliff face. The southern one is about 60 feet and the northern one about 100 feet above the creek. This cave is from 60 to 80 feet wide and 200 feet long, and reaches a height of perhaps 70 feet. It closely resembles the Nettle Cave at Jenolan. Its arched roof is decorated with tinted stalactites. The stalagmitic deposits are also tinged with pale yellow, green, or pink, &c. Near the southern entrance are four large pillars which retain their perpendicularity although they have sunk with the floor, and are now separated from the roof which they once joined by 2 or 3 feet. Looking back from the north entrance three fine massive stalagmitic deposits are seen which resemble human heads with the features in profile. One is like a queen wearing a coronet.

Twenty or 30 feet below the Colong or Key Cave an opening in the cliff face leads into the Onslow Cave. This cave contains a series of narrow passages, in some of which water is knee-deep. On the wall in one passage are numerous "shawls." These sheets of lime are earthy and opaque, but are not wanting in beauty. Numerous bats are found in this cave.

Digitized by Google

About 30 feet above the level of the southern entrance to the Colong or Key Cave is the entrance to Lannigan's Cave. The latter is probably 600 feet in length, and contains many branch passages. Some of the passages are wide and lofty, others are barely large enough to squeeze through, and all are more or less dirty under foot. The cave contains immense accumulations of bat dung. It is necessary to take great care that the dirt is not carried on to the formations, the beauty of some of which has already been marred in this way by careless visitors.

Shortly after entering the cave a ledge is seen on which are some attractive pillars. Further on a fine opaque white stalactite group hangs in the centre of the passage. In an opening to the left is a crystalline column and overhanging canopy. A semicircle of pillars and stalactites is next met with, somewhat like Nellie's Grotto at Jenolan, but not so fine. King Solomon's Temple is then entered. This chamber contains five or six large fluted and terraced columns nearly 40 feet high. One of them is surmounted by a crystalline amber-tinted formation.

Further on is a most beautiful little grotto, in which the translucent fragile stalactites are viewed through tinted and pure white and coralline stalactites and pillars.

After crawling and squeezing through a narrow passage, "The Pride of the Valley" is reached. This chamber is about 20 feet long, 10 wide, and from 5 to 8 feet high. It contains a profusion of white translucent stalactites. Two columns near its entrance are particularly fine. The beauty of the floor in one place has been spoiled by writing in pencil by some visitor. Returning, a side chamber is found to contain some attractive groups of stalactites, and a few delicate fern-like growths. Then a large chamber is entered whose floor is mostly formed of broken rocks which have fallen from the roof and sides. Here and there in it are beautiful groups of stalactites. A descent from this chamber leads to the Terraces, which may, however, be more easily reached by an opening from the passage first traversed.

The Terraces occur on a sloping floor, which they cover for a distance of perhaps 80 feet by a width of from 8 to 10 feet.

They consist of a series of crystalline basins, enclosed within white frilled and delicate rims, some of which are a foot in height. A beautiful group of stalactites and pillars serve to enhance the beauty of the formations. From the foot of the Terraces the rims of the basins have the appearance of a series of marble steps. Taken as a whole, the formation is surpassingly beautiful.

A quarter of a mile south of the Key Cave is a small cavern ornamented with coral-like formations.

North of the Key Cave, and about 10 chains east of tree broad-arrow over P3, a small hole, high up in the limestone bluff, leads down into a cavern which contains crystalline reddish and amber-tinted dripstone growths.

About 2 miles north of the Key Cave, 200 feet above Billy's Creek on its southern side, a small cavern was exhibited to me by Mr. Gaudry, which contains an oval and symmetrical bunch of the "mystery" type of dripstone formation. This specimen is about 1½ feet long by 1 foot in diameter, and is the most wonderful network of lime sprays and stalactites which I have seen. The visitor may not, however, realise its full beauty, as it occurs in a small and gloomy chamber with mud-stained walls.

Near the northern extremity of the limestone, in the vicinity of Church Creek, is the Lyttleton Cave, which, I am informed, is not particularly interesting. I did not therefore visit it.

In the Kowmung River, near at hand, good fishing is to be had, game is abundant, Wonga pigeons are plentiful; so that the locality possesses unusual attractions for the sportsman.

The caves, so far as explored, do not compare favourably with such caves as those of Jenolan, Yarrangobilly, or Wombeyan, although the Terraces in Lannigan's Cave are more extensive and beautiful than any similar formation in any other cave in the colony, so far as I am aware.

The country is marked by steep and rugged ranges and gorges with precipitous banks. It would be an exceptionally expensive undertaking to form easy tracks to the caves. I do not think such expenditure would be justified at present.

Digitized by Google

To Messrs. W. L. Gaudry, of Colong, and J. Field, of Upper Burragorang, my thanks are due for their active assistance during my inspection. These gentlemen, and Mr. J. Hilton, of Upper Burragorang, have taken considerable interest in the exploration and discovery of the several caves, and may be relied on to exhibit to visitors their several discoveries.

I have also to thank Mr. Sidman, editor of the *Camden News*; Mr. Hart, editor of the *Mountaineer*; and Mr. T. McMahon, of Cox's River, for information and assistance.

I have, &c.,
O. TRICKETT.

APPENDIX II.

Petrological Notes by H. F. Whitworth, B.Sc.

The Devonian rocks of the district represent a period of sedimentation disturbed by vulcanicity, the rock types seen being quartzites, conglomerates, hardened shales, slate, tuffs of a varying degree of fineness, and lavas grading from rhyolites to quartz andesites or dacites.

The relationships of the igneous rocks to the sedimentary is somewhat obscure, as accurate mapping in the district is rendered very difficult for the following reasons :—(1) Many of the sedimentary and tuffaceous rocks have been so altered and silicified that they resemble igneous types; (2) No "persistent horizon" to serve as a datum for accurate mapping of structures has yet been observed. This is partly due to the fact that sedimentation has been very much interrupted and lenticular beds have been produced, and partly due to the aforementioned difficulty in distinguishing one rock type from another. Very little lava occurs in the near vicinity of the lodes. Around the township of Yarranderie the majority of the rocks are silicified and hardened tuffs, some of which are so altered that they resemble a quartz porphyry. Small lenticular masses of conglomerate and hardened shale occur within the larger masses of tuffs.

The silicification of the tuffs and shale lenses is more pronounced near the township of Yerranderie than it is farther to the south-east along the river. Small dykes have been observed in the district, cutting across the tuffs and lavas. One of these cuts the lode in the Wollondilly Mine; it is of a basaltic character and is about 2 feet in thickness. Another dyke of a similar nature has been found intruding the dacites about 5 miles east of Yerranderie.

Dacites are very abundant to the east of Yerranderie. They reach from about half a mile east right down to the Wollondilly River. By a decrease of the amount of pyroxene and hornblende, and an increase in quartz, these rocks pass into the rhyolitic types which occur nearer Yerranderie. The rhyolite does not form extensive outcrops and few specimens have been collected. The dacite is a dark-bluish grey rock, in which quartz and felspar and a dark mineral can be seen with the unaided eye. Microscopically it is seen to consist of felspar and quartz phenocrysts, with a variable amount of hypersthene, augite, hornblende, biotite, and magnetite, set in a fine grained siliceous groundmass. A variation of the amount of hypersthene, augite, hornblende, and biotite gives the different types of dacites observed.

The rhyolites are lighter in colour than the dacites and contain phenocrysts of quartz and felspar with or without a little biotite and hornblende set in a stony groundmass, which under the microscope shows a ropy or fluxion structure.

The rhyolites appear to be interbedded with the tuffs around Yerranderie, whilst the dacites to the east occur in a massive sheet, with little development of tuffs. There are many types of tuffs in the district, varying from shales with a few volcanic particles, to rocks composed almost entirely of angular fragments of lavas, and which probably represent volcanic ejectamenta cemented in situ.

Digitized by Google

In the field it is impossible to definitely recognise the fragmentary nature of the fine grained tuffs as they are very compact and have been silicified. Many of the coarser tuffs can only be recognised when the weathered surface is examined, when it is seen that some portions are more easily attacked by atmospheric agencies than others, thus demonstrating their fragmentary nature.

One type of tuff which can be seen near the racecourse and also near the Wollondilly Mine consists almost entirely of quartz, felspar, and ilemnite closely packed together and cemented by green chloritic material. Rock fragments are present but are not plentiful. This rock has been silicified and even under the microscope bears a likeness to a quartz porphyry. This "crystal tuff" forms the country rock of the Wollondilly Mine and also occurs at the eastern end of Bartlett's Colon Peak Mine.

About 5 miles east of Yerranderie two small veins occur in a granitic intrusion. The granite is a light-coloured acid type, and is instrusive into the Devonian rocks which have suffered a slight amount of contact metamorphism. The granite appears to be the fringe of a large plutonic intrusion, most of which is hidden by overlying sedimentary rocks.

The country rocks on either side of the main lodes have been highly altered, presumably by the lode forming solutions. This has rendered an exact determination of these rock types impossible. They are somewhat crushed and impregnated with secondary minerals such as pyrites, epidote, calcite, silica, and secondary micaceous minerals, and, in addition their original minerals have been altered or entirely removed. This latter action is especially noticeable in the case of felspar, which is generally represented by a pseudomorph of calcite or secondary mica.

From an examination of many different specimens of country rock taken from both foot and hanging walls in the Wollondilly, Colon Peak, and Silver Peak Mines, it is seen that there are changes in the country across which the lodes run. Altered tuffs, altered rhyolite and slate have been seen, whilst many specimens were too altered to be recognisable.

It is suggested that these changes in country rock are connected with the alternate enrichments and impoverishments of the main lodes, which give the valuable "bunches" of ore interspaced with barren channel rock.

Mr. J. Gordon McKern, B.E., a former petrologist to the Geological Survey, supplied the following notes on Yerranderie rocks, but he points out that his examination was incomplete.

The evidence as to vulcanicity may be summed up as follows:—

1. Absence or very little contact action on adjoining rocks, *e.g.*, Tonalli Creek section below Newtown where a flow disappears under quartzite. Quite normal sedimentation follows a general plane contact, a pebbly conglomerate being the first deposition, following by a gritty quartzite and then by a fairly dense quartzite. It is hardly likely that a sill would have selected that horizon for intrusion, and if the felsite represented is denuded intrusion surely there would have been some contemporaneous erosion, not a plane contact.

2. Irregular fragments of other rocks are to be seen included in the volcanic rocks, particularly in the area south-east of the hotel.

3. Striping and colour banding noticeable in large specimens possibly indicative of pseudo-stratification.

4. Accompaniment of lavas by much fragmental material. The bowls and the agglomerates noticed were possibly the only definite type of evidence of this class that could be picked out in the field, the tuffs and fine breccias not being generally recognisable as such in hand specimens. However, much microscopic evidence of this nature has been accumulated. Generally speaking, they are crystal tuffs with accompanying small pea-eyed fragments of rhyolites, argillite with occasional devitrified glass. In one case a tuff contained fragments of an earlier tuff. The rhyolite fragments are generally of felsitic type with small phenocysts and occasional flow structure. The cement is sometimes ashy and other times a lava producing in the later case a flow breccia.

Digitized by Google

There is in one or two field sections sufficient evidence to indicate the nature of the vulcanicity over a certain interval of time. For example, in the gully about 30 chains south-east from the hotel. Proceeding down the gully we have the following sequence. First almost in the bed of the creek is fresh grey hard rock with nearly rounded quartzite pebbles and small pieces of argillite. Under the microscope the matrix is clearly a crystal tuff and I would suggest the large pebbles were picked up on the regolith which developed after a period of quiescence. A few feet above this on the right bank is a hard lumpy-fractured rock with dark-green chloritic areas. Studied in conjunction with a fresher rock taken from the "racecourse" which is probably identical, it is also seen to be a crystal tuff with a little microspherulitic rhryolite also as included fragments. One chain further down the creek is to be seen a hard dark-grey nearly aphanitic rock in which may be seen occasional euhedral felspar. Under the microscope it is a tuff crowded with broken crystals, and also containing a large piece of an already consolidated tuff which is in part rhyolitic. This apparently indicates more or less spasmodic or recurrent volcanic outpourings of an explosive nature. About 4 chains further down the gully is a pale-green hard rock weathering creamy buff with uneven to hackly fracture; there are pink felspars up to 2 mm. long, showing good forms and glassy quartz in a slightly streaky groundmass. Under the microscope the rock appears to be a fluidal rhyolite. The Basin Creek road section is mainly lava, with probably a flow-breccia initiating the cycle—this is the lumpy-fractured greenish-grey hard rock some 10 or 12 chains from the creek crossing up towards Yerranderie. This is followed by a creamy-brown jointed rock which is quartz porphyry in character and probably lava. Then comes a dull brown decomposed rock with a little pale-green fresh patches in it. This is also a tuffaceous lava, and for the remainder of the section down to the creek, it is where examined, a felsitic rhyolite. As to the dacite-felsite junction at the confluence of Basin Creek and Tonalli River, all the evidence indicates that the area to the east is at least largely dacite. Going up the slope on the left bank of Basin Creek three specimens were obtained in the following sequence.

[11,518] 5 chains from Tonalli, left bank of Basin Creek 60 feet above bed—a jointed tuff, hard silicified quartz felcite which is common to the area between the town and Basin Creek in this area.

[11,520] about 100 feet higher up on the same bank is a greenish rock weathering red, uneven in facture and sub-vitreous in lustre. Occasional large quartz (corroded) phenocrysts are visible. The felspar is too altered for determination, and the rock generally much replaced by carbonates, &c., but it has the general appearance under the microscope of being one of the dacite type. Generally speaking the dacites have large quartz bulbs up to 3-4 mm. diam., whereas the rhyolites have small phenocrysts with felspar and quarts phenocrysts generally not more than 1-2 mm. diameter.

With regard to the dacite generally, it appears to encircle Yerranderie from Tonalli Creek, out to the east and down south, round to the south-east generally at a distance of from 2½ to 3 miles from the hotel. This would make it appear as if it were from a common centre with the rhyolite, and later than the latter. That is apparently not borne out by the examination of the rocks from the central area in the vicinity of the Wollondilly Mine, which are very coarse shattered quartz porphyries crowded with phenocrysts. With regard to the central area, all the rocks I have examined from P.F.L. 2 to P.M.L.'s 10 and 18 are of the same brecciated appearance, and if further rock specimens from this neighbourhood bear it out and some field evidence is forthcoming it might be classed as intrusive—the denuded stump of a volcano.

[15 Plates, 11 Plans, and Map and Sections 1, 2 and 3.]

Sydney: Alfred James Kent, I.S.O., Government Printer—1930.

Digitized by Google

Digitized by Google

To renew the charge,

DO NOT R

SCIENCE

TN
122
N421
A3

no.26-35

New
Ge
Miner
1917/

comm bind

S.J Boardman
2065 NS

Form 7079a

UNIVERSITY
3 9015 0685

Digitized by Google